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MERGERS OF LUMINOUS EARLY-TYPE GALAXIES IN THE LOCAL UNIVERSE AND GRAVITATIONAL WAVE BACKGROUND

Z. L. WEN[1,3], F. S. LIU[2,1], AND J. L. HAN[1]

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ABSTRACT

Supermassive black hole (SMBH) coalescence in galaxy mergers is believed to be one of the primary sources of very low frequency gravitational waves (GWs). Significant contribution of the GWs comes from mergers of massive galaxies with redshifts $z < 2$. Very few previous studies gave the merger rate of massive galaxies. We selected a large sample (1209) of close pairs of galaxies with projected separations $7 < r_p < 50$ kpc from 87,889 luminous early-type galaxies ($M_r < -21.5$) from the Sloan Digital Sky Survey Data Release 6. These pairs constitute a complete volume-limited sample in the local universe ($z < 0.12$). Using our newly developed technique, 249 mergers have been identified by searching for interaction features. From them, we found that the merger fraction of luminous early-type galaxies is 0.8%, and the merger rate in the local universe is $R_g \sim (1.0 \pm 0.4) \times 10^{-5}$ Mpc^{-3} Gyr^{-1} with an uncertainty mainly depending on the merging timescale. We estimated the masses of SMBHs in the centers of merging galaxies based on their luminosities. We found that the chirp mass distribution of the SMBH binaries follows a power law with an index of -3.0 ± 0.5 in the range 5×10^8–5×10^9 $M_\odot$. Using the SMBH population in the mergers and assuming that the SMBHs can be efficiently driven into the GW regime, we investigated the stochastic GW background in the frequency range 10^{-9}–10^{-7} Hz. We obtained the spectrum of the GW background of $h_c(f) \sim 10^{-15}(f/\mathrm{yr}^{-1})^{-2/3}$, which is one magnitude higher than that obtained by Jaffe & Backer in 2003, but consistent with those calculated from galaxy-formation models.

Subject headings: galaxies: interactions — galaxies: general — black hole physics — gravitational waves

1. INTRODUCTION

Gravitational waves (GWs) are a new window to observe violent astrophysical dynamic processes. Efforts in the detection of GWs are currently being made at several frequency bands. For example, the Laser Interferometer Gravitational Wave Observatory (LIGO) aims to detect GWs in the frequency range 1–10^4 Hz (Abramovici et al. 1992) emitted from the coalescence of binary compact objects or from the cosmic GW background. In the frequency range 10^{-6}–0.1 Hz, the Laser Interferometer Space Antenna (LISA) is expected to detect the GWs emitted from the coalescence of massive black hole (BH) binaries in the mass range 10^3–10^7 $M_\odot$ and from the unresolved white dwarf binaries in the Milky Way and nearby galaxies (Haehnelt 1994; Nelemans et al. 2001). Precision timing of millisecond pulsars appears to be a unique technique (Sazhin 1978; Detweiler 1979; Jenet et al. 2005; Jenet et al. 2006) to measure GWs emitted from the coalescence of supermassive black holes (SMBHs) with masses 10^7–10^{10} $M_\odot$ in galactic nuclei, cosmic superstrings, and relic GW background from the big bang (Maggiore 2000; Phinney 2001; Jaffe & Backer 2003) in the frequency range 10^{-9}–10^{-7} Hz.

The SMBH mergers at redshifts $z < 2$ dominate the GW background and resolvable signal at a frequency band 10^{-9}–10^{-7} Hz (Wyithe & Loeb 2003; Sesana et al. 2004, 2008a,b). Only galaxy mergers provide a chance for the SMBH mergers. At present, the galaxy merger history is not very clear. The evolution of the merger rate is often described by a power law, $R_g(z) \propto (1+z)^m$, where, m is the evolution index. However, the merger rate of massive galaxies has not been determined precisely from observations. In the rest of the introduction, we will review the current knowledge on galaxy pair fraction and merger rate, and then discuss current understanding on GWs from SMBH coalescence.

In this paper, we assume a ΛCDM cosmology taking H_0 =100 h km s^{-1} Mpc^{-1}, with h = 0.72, Ω_m = 0.3 and Ω_Λ = 0.7.

1.1. *Galaxy pair fraction and merger rate: current knowledge*

Three methods have previously been applied for measurement of the merger rate and its evolution. The first and most straightforward is to count the incidence of strong disturbed galaxies with double nucleus, or tidal tails (e.g. Le Fèvre et al. 2000; Conselice et al. 2003a,b; Lavery et al. 2004; van Dokkum 2005; Kampczyk et al. 2007; Lotz et al. 2008). The second is to take statistics of close pairs from a spectroscopic redshift survey assuming that the close pairs will result in galaxy mergers over a relatively short timescale (Zepf & Koo 1989; Burkey et al. 1994; Carlberg et al. 1994; Yee & Ellingson 1995; Woods et al. 1995; Neuschaefer et al. 1997; Patton et al. 1997; Wu & Keel 1998; Patton et al. 2000; Patton et al. 2002; Bundy et al. 2004; Lin et al. 2004; De Propris et al. 2005, 2007; Bell et al. 2006a; Kartaltepe et al. 2007; Lin et al. 2008; Patton & Atfield 2008). Physical pairs with separations $r_p < 20$ h^{-1} kpc and line-of-sight velocity differences $\Delta v < 500$ km s^{-1} are expected to merge within 0.5 Gyr (Patton et al. 2000; Conselice 2006). Key problems of such studies were the very limited number of galaxies with spectroscopic redshifts, the incompleteness of the sample, and the contamination of

[1] National Astronomical Observatories, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100012, P.R.China; zhonglue@bao.ac.cn, hjl@bao.ac.cn.
[2] College of Physics Science and Technology, Shenyang Normal University, Shenyang 110034, P.R.China; lfs@bao.ac.cn.
[3] Graduate University of the Chinese Academy of Sciences, Beijing, 100049, P.R.China

unphysical pairs (Patton et al. 2000; De Propris et al. 2007). Another useful but less direct method is the statistics of close pairs from the two-point correlation function of galaxies at small scales (e.g. Masjedi et al. 2006; Bell et al. 2006b). The projected correlation function can be obtained from a large sample of galaxies, and can be "deprojected" to get the real-space correlation function.

Morphological signatures of interactions can be found by visual inspection, which is very time consuming and somewhat subjective. Some excellent studies have been published recently. Le Fèvre et al. (2000) studied merger fraction using 285 galaxies from the Canada–France Redshift Survey and Autofib-Low Dispersion Spectrograph Survey. They found 49 pairs by visual identification, 37 of which have a Lee ratio $L_R > 1.5$. Combining the result given by Patton et al. (1997), Le Fèvre et al. (2000) determined the merger fraction evolution as $2.1\% \times (1+z)^{3.4\pm0.6}$. Conselice et al. (2003a) studied the fraction of galaxies undergoing major mergers as a function of redshift using model-independent morphological signatures (concentration, asymmetry, clumpiness) in the WFPC2 and NICMOS Hubble Deep Field North. Their samples have 51, 142, 93, and 183 galaxies ($M_B < -18$) in the four redshift ranges with $\langle z \rangle$ = 0.58, 1.10, 1.73, and 1.41, respectively. They found that the corresponding merger fractions are 4%, 14%, 14%, and 9%. Recently, Lotz et al. (2008) found 312 merger candidates with morphological disturbances based on a volume-limited sample of 3009 galaxies ($M_B < -18.94$) from the All-Wavelength Extended Groth Strip International Survey. A constant merger fraction of $(10\pm2)\%$ was found in the redshift range of z = 0.2–1.2.

There has been much effort applied to the statistics of close pairs, as summarized in Table 2 of Kartaltepe et al. (2007). Carlberg et al. (2000) selected kinematic pairs of galaxies ($M_B - 5\log h < -19.8$) with $5 < r_p < 100\ h^{-1}$ kpc and $\Delta v < 1000$ km s^{-1} in the redshift range of z = 0.1–1.1. They found 18 pairs from 300 galaxies of the Caltech Faint Galaxy Redshift Survey and 91 pairs from 3000 galaxies of the Canadian Network for Observational Cosmology. Patton et al. (2000) defined N_c, "the number of dynamically close *companions per galaxy*", to study the pair fraction. From 5426 galaxies ($-21 < M_B < -18$) in the Second Southern Sky Redshift Surveys, they found 80 *companions* satisfying the conditions $5 < r_p < 20\ h^{-1}$ kpc and $\Delta v < 500$ km s^{-1}, and derived $N_c = (2.26 \pm 0.52)\%$ at an average redshift $\langle z \rangle$ = 0.015. Using the same selection criteria, Patton et al. (2002) identified 88 galaxies in close pairs from 4184 field galaxies at redshifts $0.12 \le z \le 0.55$ from the Canadian Network for Observational Cosmology. They obtained $N_c = (3.21 \pm 0.77)\%$ at redshift $\langle z \rangle$ = 0.3. Combing the early result in Patton et al. (2000), they also determined the merger rate evolution as $(1+z)^{2.3\pm0.7}$. Lin et al. (2004) found 79 paired galaxies ($10 < r_p < 50\ h^{-1}$ kpc, $\Delta v < 500$ km s^{-1}) out of 2547 galaxies from the initial data of the DEEP2 Redshift Survey, and found that the pair fraction N_c is $\sim 8\%$ at redshift $z \sim 0.6$ and increases to $\sim 10\%$ at redshift $z \sim 1.1$. Fitting a power-law model to the pair fractions determined from higher redshift together with those determined at lower redshift (Patton et al. 2000; Patton et al. 2002), Lin et al. (2004) obtained the evolution index $m = 0.51 \pm 0.28$. From the Millennium Galaxy Catalogue, De Propris et al. (2005) found 137 dynamically close companions ($5 < r_p < 20\ h^{-1}$ kpc, $\Delta v < 500$ km s^{-1}) in a bright sample ($-22 < M_B - 5\log h < -19$) and 176 companions in a faint sample ($-22 < M_B - 5\log h < -18$). They found the pair fractions $N_c = (1.74 \pm 0.15)\%$ at redshift $\langle z \rangle$ = 0.123 and $(3.57 \pm 0.27)\%$ at redshift $\langle z \rangle$ = 0.116, respectively, after a correction for ($\sim 30\%$) missing pairs.

Above studies have used relatively small samples. Recently, 1749 close pairs ($5 < r_p < 20$ kpc) have been found by Kartaltepe et al. (2007) from a complete sample of 59,221 galaxies ($M_V < -19.8$) in the redshift range of z = 0.1–1.2 from the Cosmic Evolution Survey field. This is the largest data set of close pairs. Supplemented by the local pair fraction from the Sloan Digital Sky Survey (SDSS), they found the pair fraction evolution to be $(1+z)^{3.1\pm0.1}$. Note that the majority of these statistics were studied for general mergers, using close pairs selected with small radial velocity differences and small projected separations.

Recently, several studies have been carried out on mergers between gas-poor early-type massive galaxies, also called "dry merger" (Bell et al. 2006a; Lin et al. 2008). Masjedi et al. (2006) studied the merger rate of Luminous Red Galaxies in the SDSS using the two-point correlation function. They found that the correlation function closely follows $\xi(r) \sim r^{-2}$ over four orders of magnitude, from 0.01 to 100 h^{-1} Mpc. Taking a merger length scale of r_f = 10 kpc and a typical velocity dispersion, $\sigma_v \sim 200$ km s^{-1}, the dynamical time is about $t_{\rm dyn}$ =200 Myr. The merger rate per galaxy, Γ, for galaxies with a comoving number density, $n = 10^{-4}$ Mpc^{-3}, is

$$\Gamma \approx \frac{4\pi n\, r_f^2 \xi(r_f)}{t_{\rm dyn}} = \frac{1}{160\ {\rm Gyr}}.$$

We can further find a comoving volume merger rate of galaxies,

$$R_{\rm g} \equiv n\Gamma = 6 \times 10^{-7}\ {\rm Mpc^{-3}\ Gyr^{-1}}. \quad (1)$$

Note that this is one magnitude smaller than that of Masjedi et al. (2006).[4] Bell et al. (2006a) found six dry mergers (12 galaxies) from 468 early-type galaxies ($M_V < -20.5$) in the redshift range of z = 0.1–0.7 from the Galaxy Evolution from Morphology and spectral energy distributions (SEDs) survey. Their simulations show that *the distinct interaction features in the mergers of early-type galaxies only appear in the last pass or coalescence*. Following this, McIntosh et al. (2008) identified 38 merging pairs of massive galaxies (stellar masses $M_{\rm star} > 5 \times 10^{10}\ M_\odot$ and $r_p \le 30$ kpc) from 845 galaxy groups/clusters at redshifts $z < 0.12$ in the SDSS Data Release 2 (DR2). They found that the merger rate of massive galaxies in the galaxy groups is several times higher than that of the SDSS Luminous Red Galaxies. Lin et al. (2008) studied the evolution of pair fraction and merger rate for different types of pairs of galaxies ($-21 < M_B < -19$) with $10 < r_p < 30$, 50, 100 h^{-1} kpc and $\Delta v < 500$ km s^{-1}. Their sample includes 218 blue–blue pairs, 122 red–red pairs and 166 red–blue pairs in the redshift range of z = 0.1–1.2 from Team Keck Redshift Survey and other surveys mentioned above. They found that the merger rate evolutions are different for different types of pairs. The blue–blue pairs have a merger rate evolution index $m = 1.27 \pm 0.35$, whereas the red–red pairs and red–blue pairs have negative indices, as -0.92 ± 0.59 and -1.52 ± 0.42, respectively.

In summary, most previous studies work on the pair fraction and merger rate of a general merger. The pair fraction varies in a range of 1%–10% in the redshift range of z = 0.2–1.2 with an evolution index of $m = 0-3$. Only a few authors have

[4] Equation (12) in Masjedi et al. (2006) has a wrong form of Γ/n.

tried to determine merger rates for different types of galaxies. The mergers of early-type galaxies have been explored only recently (Bell et al. 2006a; Masjedi et al. 2006; Lin et al. 2008; Lotz et al. 2008). The large uncertainty of merger rate remains due to either the small sample or the contamination of unphysical pairs. The merger rate should be better determined using the fraction of merging galaxies, rather than the fraction of galaxies in the projected close pairs.

Using the SDSS data, we select a large complete volume-limited pair sample of luminous early-type galaxies and try to determine the merger rate in the local universe ($z < 0.12$). The BHs in the luminous early-type galaxies are much more massive than those in late-type galaxies, and their mergers will play an important role in the formation of massive galaxies and SMBH binaries.

1.2. *SMBH mergers and GWs*

SMBHs exist in the nucleus of nearby and distant galaxies. When two galaxies merge, the SMBHs in the centers of galaxies sink toward the center of a newly formed galaxy through dynamic friction (Begelman et al. 1980; Yu 2002), and then a SMBH binary can be formed. The SMBH binary continues to harden (i.e., lose energy, shrink, and move faster) and becomes a bound system through, e.g., stellar dynamics (Quinlan 1996; Milosavljević & Merritt 2001; Sesana et al. 2006) or gas dynamics (Gould & Rix 2000; Armitage & Natarajan 2002; Escala et al. 2004; Dotti et al. 2007). Consequently, the SMBH binary loses energy and angular momentum by GW radiation, and eventually coalesces to produce a luminous GW event.

The GWs emitted from SMBH binaries can be detected as individual sources and a stochastic background from many events together. Recent studies (Sillanpaa et al. 1988; Sudou et al. 2003; Valtonen et al. 2008) have suggested that SMBH binaries may exist in the centers of galaxies with orbit periods of a few years. They are possible individual GW-emitting sources to be revealed by pulsar timing observations. The GW amplitude from a SMBH binary is (Thorne 1987)

$$h_s = 4\sqrt{\frac{2}{5}}\frac{(GM_c)^{5/3}}{c^4 D(z)}[\pi f(1+z)]^{2/3}, \quad (2)$$

where M_c is the chirp mass of the SMBH binary,

$$M_c^{5/3} = \frac{M_1 M_2}{(M_1+M_2)^{1/3}}; \quad (3)$$

here M_1 and M_2 are SMBH masses; f is the observed GW frequency; c is the speed of light; $D(z)$ is the comoving distance to the system located at z,

$$D(z) = \frac{c}{H_0}\int_0^z \frac{dz}{E(z)}; \quad (4)$$

here $E(z) = \sqrt{\Omega_\Lambda + \Omega_m(1+z)^3}$. The frequency change of the GW per unit time in the observer's frame is given by Peters & Mathews (1963):

$$\frac{df}{dt} = \frac{96}{5\pi}\left(\frac{GM_c}{c^3}\right)^{5/3}(\pi f)^{11/3}(1+z)^{5/3}. \quad (5)$$

A large number of unresolved coalescing SMBH binaries together can produce a stochastic GW background. The spectrum can be formulated as (Phinney 2001; Jaffe & Backer 2003; Enoki et al. 2004)

$$h_c^2(f) = \int dz\, dM_c\, h_s^2 N(f,z,M_c)\ f\ \theta(f_{\rm max}-f), \quad (6)$$

where $N(f,z,M_c)\,dz\,dM_c$ is the number of SMBH binaries per unit frequency in mass interval dM_c and redshift interval dz. The $\theta(x)$ in Equation 6 is the step function (Enoki et al. 2004) and $f_{\rm max} = c^3/[6^{3/2}\pi G(M_1+M_2)]$ is the maximum frequency of the GW before the SMBHs plunge together (Hughes 2002). $N(f,z,M_c)$ is related to the merger rate of SMBH per unit comoving volume, $R_{\rm BH}(z)$, by

$$N(f,z,M_c) = \frac{4\pi c^3}{H_0^3}\frac{D(z)^2}{E(z)(1+z)}\frac{dt}{df}\frac{\Phi(M_c,z)}{n_{\rm BH}(z)}R_{\rm BH}(z), \quad (7)$$

here, $\Phi(M_c,z)$ is the chirp mass distribution of SMBH binaries; $n_{\rm BH}(z) = \int \Phi(M_c,z)\,dM_c$ is the number density of SMBH binaries.

Rajagopal & Romani (1995) estimated the number of GW-emitting sources by examining the probability of SMBH binary coalescence through the process by interaction with field stars. They used the SMBH mass function from the model of active galactic nuclei (AGNs; Small & Blandford 1992) and a merger rate evolution as $(1+z)^{3.5}$. Finally, they obtained a GW spectrum of $h_c(f) \sim 10^{-16}(f/{\rm yr}^{-1})^{-2/3}$ at frequency $f \sim 0.1-1{\rm yr}^{-1}$. Phinney (2001) further formulated the calculation of the GW background, and obtained the spectrum in a power law $h_c(f) \sim f^{-2/3}$. He found that the GW spectrum index is independent of cosmology. The amplitude is in an order of $\sim 10^{-16}$ at the frequency of $1{\rm yr}^{-1}$ which depends on the merger rate of SMBHs and the SMBH population in the universe.

Jaffe & Backer (2003) formulated all ingredients including the merger rate of SMBHs, the distribution of SMBH masses, the strain of the GW background for a single binary, and the GW radiation timescale ($\tau_{\rm GW} = f\,dt/df$). They obtained the spectrum[5] of $h_c(f) \sim 10^{-16}(f/{\rm yr}^{-1})^{-2/3}$, confirming the results of Rajagopal & Romani (1995) and Phinney (2001). They also found that the slope of the spectrum is determined by the strain and timescale of individual merger event, independent of the merger models and SMBH population. The large uncertainty of the spectrum amplitudes comes from approximations in the theoretical formulation, lack of knowledge of the merger rate and SMBH population, and unknown dynamical processes of SMBH binary to reach a GW-dominated regime.

To minimize the uncertainties, some efforts have been made to calculate the GW background utilizing the galaxy merger rate and the SMBH population based on the standard hierarchical structure formation scenarios (Wyithe & Loeb 2003; Enoki et al. 2004; Sesana et al. 2004, 2008a). These studies show that the amplitude of the GW background is a few times higher than those given by Phinney (2001) and Jaffe & Backer (2003). The characteristic strain spectrum is dominated by SMBHs with masses larger than $10^9\ M_\odot$ at low redshifts ($z < 2$), and the spectrum becomes steeper than $-2/3$ when the frequency is larger than about 10^{-7} Hz.

Clearly, observational determination of the merger rate of SMBHs and the SMBH mass function in the binaries is crucial for a more precise calculation of the GW background. This paper is organized as follows. In Section 2, we describe the identification of merging pairs and determine the merger rate of luminous early-type galaxies in the local universe. In Section 3, we derive the chirp mass distribution of the SMBH binaries in the mergers and calculate the spectrum amplitude of the GW background. We give conclusions in Section 4.

[5] The authors misquoted the strain amplitude of $h_c(f) \sim 10^{-15}(f/{\rm yr}^{-1})^{-2/3}$ in their abstract.

2. PAIR FRACTION AND MERGER RATE OF LUMINOUS EARLY-TYPE GALAXIES IN THE SDSS

To determine the pair fraction and merger rate of luminous early-type galaxies in the local universe, we selected a large and complete sample of close pairs of galaxies ($M_r < -21.5$) at redshifts $z < 0.12$ directly from the SDSS DR6. The SDSS provides photometric data in five broad bands (u, g, r, i, and z) for more than 8400 deg^2 to the limit of $r = 22$ mag, deeper than any previous wide sky surveys. The follow-up spectroscopy observations have measured spectra of more than 790,000 galaxies in about 7425 deg^2 (Adelman-McCarthy et al. 2008). The main galaxy sample reaches an extinction-corrected Petrosian magnitude of $r = 17.77$ (Strauss et al. 2002) and a completeness of $\sim$90% (Blanton et al. 2003). We selected this sample of projected close pairs incorporating the spectroscopic with photometric catalogs, and then identified the mergers by searching for the interaction features.

2.1. *Pairs of luminous early-type galaxies: sample*

In previous studies, close pairs were usually selected using the criteria $\Delta v < 500$ km s^{-1} and $r_p < 20\ h^{-1}$ kpc or $r_p < 30\ h^{-1}$ kpc (see Section 1.1). However, direct searches of pairs from the SDSS spectroscopic catalog would miss $\sim$70% of close pairs due to the fiber collision problem (McIntosh et al. 2008). Targets of the spectroscopic survey are assigned to fibers with a radius of 1.5 arcsec, and two fibers cannot be placed more closely than 55 arcsec. The incompleteness is severe on very small angular scales. However, the estimated photometric redshifts (Oyaizu et al. 2008) can be used as the complement of the spectroscopic redshifts of galaxies.

We obtained a complete pair sample of luminous early-type galaxies from the SDSS with the following steps. We found the redshifts of bright galaxies ($13.5 < r < 17.5$) and constructed a sample of close pairs with projected separations $7 < r_p < 50$ kpc at redshifts $z < 0.12$. The photometric redshifts are taken for the galaxies without spectroscopic redshifts. If the spectroscopic redshifts are available for both galaxies in a pair (i.e., the spec–spec pair), *the redshift for the pair* is taken as the average of the two redshifts. If the spectroscopic redshift is available for only one of the paired galaxies (i.e., the spec–phot pair), it is taken as the pair redshift. If no spectroscopic redshifts are available for both galaxies (i.e., the phot–phot pair), the pair redshift has to be taken as the average of the two photometric redshifts. The lower limit of 7 kpc in separation corresponds to $\sim 3''$ at redshift $z = 0.12$. The photometry becomes unreliable for paired galaxies with smaller angular separations (Masjedi et al. 2006). The upper limit of 50 kpc is chosen so that all merging pairs, even the one with a large separation, can be included in our sample. We restricted the redshift range of $z < 0.12$ to get enough samples for our statistics and to have the galaxies well resolved for the further image analysis. We applied the K-correction for all galaxies to the rest frame (Blanton & Roweis 2007). The galaxies in the pairs must have $M_r < -21.5$ and satisfy the color constraints of $(u-r) > 2.2$ and $(g-r) > 0.7$ (Strateva et al. 2001). However, the sample is still contaminated by some red late-type galaxies, e.g., edge-on spiral galaxies with dust lanes or galaxies with red bulges, which were about 10% and have been excluded by visual inspection on color images of all targets from the *DR6 Catalog Archive Server*[6]. Following the above selection criteria, we obtained 1209 pairs from 87,889 galaxies with $M_r < -21.5$ at redshifts $z < 0.12$. There are 230 spec–spec pairs, 543 spec–phot pairs and 436 phot–phot pairs. These pairs are listed in Table 1 (a full list is available in the online version).

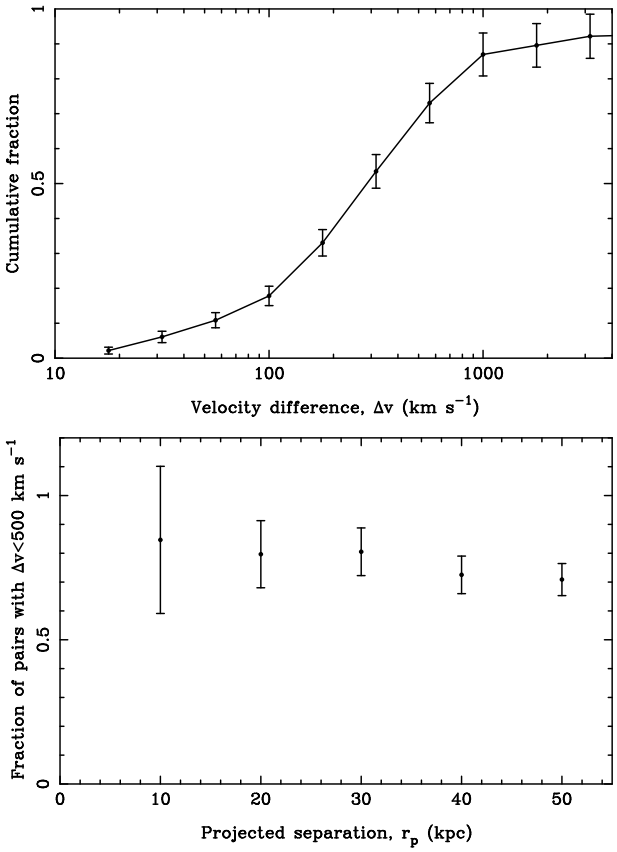

FIG. 1.— Top: distribution of line-of-sight velocity differences for the spec–spec pairs. Bottom: fractions of pairs with velocity differences $\Delta v <$ 500 km s^{-1} for various maximum projected separations.

Figure 1 shows the distribution of line-of-sight velocity differences for the spec–spec sample. 71% of the pairs have $\Delta v < 500$ km s^{-1}. We also show in Figure 1 the fraction of pairs with $\Delta v < 500$ km s^{-1} as a function of projected separation. Among the close pairs with $r_p < 30$ kpc, 81% have the $\Delta v < 500$ km s^{-1}.

2.2. *Identification of mergers*

Most of the previous efforts in the determination of the merger rate used the projected close pairs. Very few groups (Bell et al. 2006a; McIntosh et al. 2008) identified interaction features for pairs of luminous early-type galaxies. The apparent close pairs may be widely separated in a three-dimensional space. It is necessary to check how many of the projected close pairs are merging.

In merging galaxies, stars and gas may be torn apart from parent galaxies under tidal force. The induced asymmetric features (such as tails, bridges and plumes) can be used as evidence for galaxy interactions. Interaction involving at least one gas-rich late-type galaxy usually accompanies strong star forming and creates distinct long tidal tails. Such a merger is distinct and easy to identify. In contrast, merger involving only gas-poor early-type galaxies usually does not create distinct interaction features. However, the weak features of early-type galaxy merging can be identified after a smooth

[6] http://cas.sdss.org/astro/en/

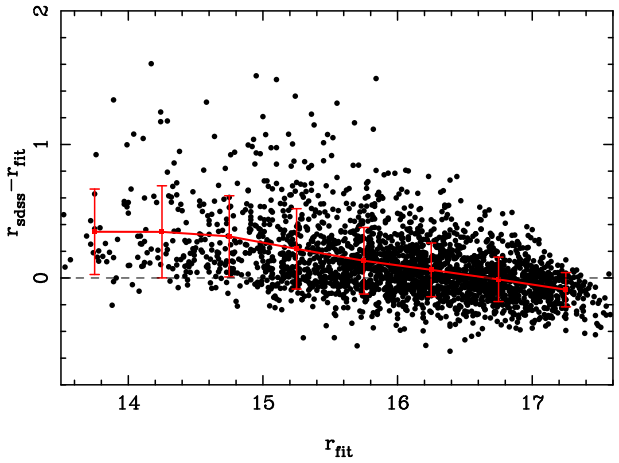

FIG. 2.— Difference between the SDSS model magnitude and our fitted magnitude against the fitted magnitude for paired galaxies.

symmetric model for each paired galaxy is subtracted from the image (Bell et al. 2006a; McIntosh et al. 2008).

We extracted the SDSS *r*-band images for all selected pairs. The corrected frames have been processed by the SDSS pipeline, including bias-subtraction, flat-field, cosmic-ray removal, and correction for pixel defect. We performed a precise sky background subtraction from the corrected frames (see details in Liu et al. 2008). We applied the GALFIT package (Peng et al. 2002) to construct a smooth symmetric model for every early-type galaxy in the projected pair list. The model fitting requires an observational image, a masked image, and an image of the point-spread function (PSF) that is the seeing of SDSS images characterized by the parameters of double-Gaussian profiles (Stoughton et al. 2002). From the SDSS catalog, we also obtained a list of other fainter galaxies and stars within $2R_{90}$ from the centers of two galaxies. Here R_{90} is the radius containing 90% of the Petrosian flux. The stars have directly been modeled with the PSF, but the target early-type galaxies and other fainter galaxies have been modeled by the Sérsic function (Sérsic 1968) convolved with the PSF image. Objects *outside* $2R_{90}$ in the extracted image were masked. The fitting is to minimize the χ^2 between the sky-subtracted image of unmasked pixels and the PSF-convolved model for paired galaxies and other objects in the image.

The modeling procedure provides a fitted magnitude for each galaxy, which is the integrated flux of the best-fitted Sérsic function. The advantage of the fitted magnitude is that the fluxes from both galaxies in the overlapped region can be separated. Moreover, we have corrected the sky background for bright objects and objects in crowded fields in the SDSS pipeline (see more detailed discussion and solution in Liu et al. 2008), which would result in a systematic underestimation for luminosities (and sizes) of bright objects in the SDSS pipeline (Mandelbaum et al. 2005; Lauer et al. 2007; Liu et al. 2008). Brighter galaxies tend to be influenced more severely (see Figure 3 of Liu et al. 2008). This tendency can be seen in Figure 2 from a rough comparison between the fitted magnitudes and the SDSS model magnitudes. Therefore, the fitted magnitudes are adopted in the following analysis.

Figure 3 illustrates six examples of GALFIT fitting. The top three pairs with significant interaction signatures (e.g., short tidal tails, bridges) in the residual images (*right panels*) are considered as the merging systems. In contrast, there are no

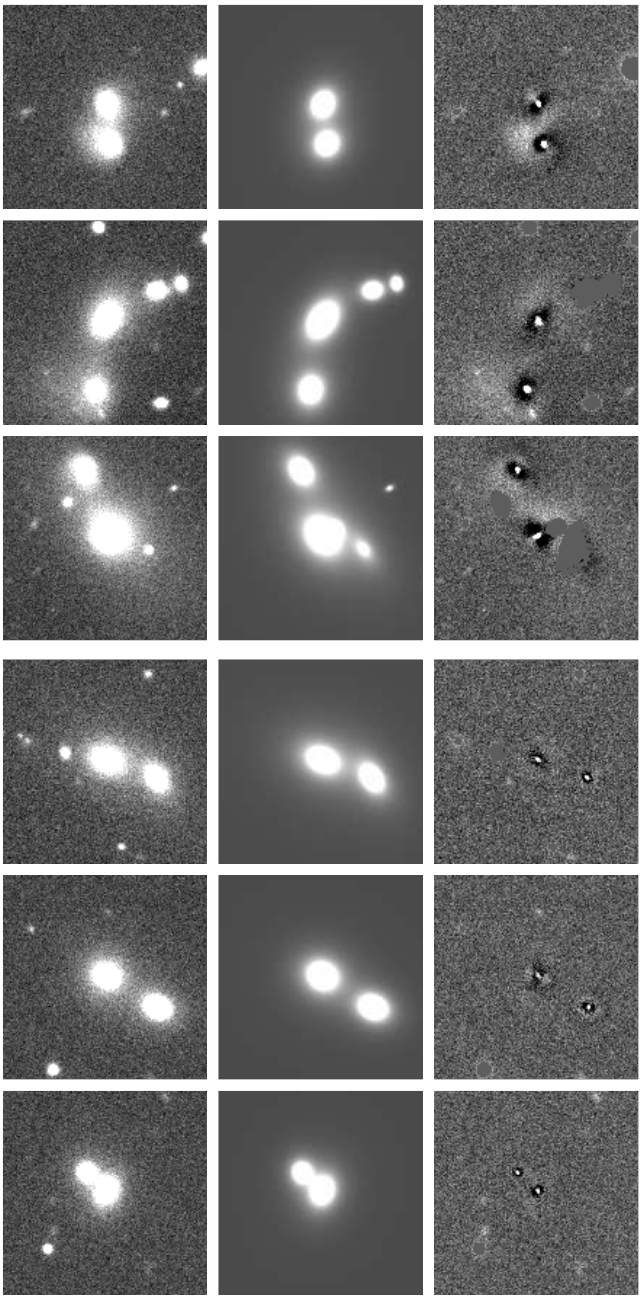

FIG. 3.— Examples of the sky-subtracted images *(left)*, the models with GALFIT *(middle)*, and the residual images *(right)* for merging *(top 3)* and nonmerging pairs *(bottom 3)*.

obvious interaction features in the residual images of the bottom three examples. The lack of clear interaction signatures suggests that these pairs may be either due to projection effects or at early stages of interaction.

Quantitative criteria are needed to identify interaction signatures. We noted that Conselice et al. (2000) developed a method to estimate the rotational asymmetry of galaxies and identify major mergers (Conselice et al. 2003a; De Propris et al. 2007). In this paper, we measured the asymmetry factors of early-type galaxy pairs from the residual images (see an example in Figure 4). The photometric region *A* or *B* is within $3R_e$ but not overlapped. Here R_e is the effective radius, a parameter in the fitted Sérsic function. The

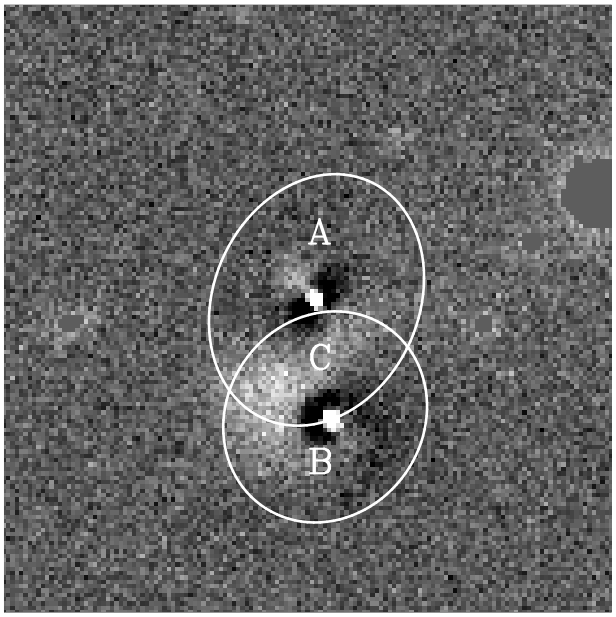

FIG. 4.— An example of the residual image of a galaxy pair. The ellipses mark the regions with three times of the fitted major and minor axes of the Sérsic function for each galaxy. The paired galaxies are overlapped in the region of *C*.

overlapped region is marked as region *C*. Our asymmetry calculation is to measure the difference between any pixels and those symmetric pixels with respect to galactic centers. Two different cases exist. One is a pair of pixels within the region *A* or *B*; the other is a pixel triplet, with one pixel in the region *C*, but it has symmetric pixels in region *A* and *B* (or even *C*). It is supposed that there are N_A pairs in region *A*, N_B pairs in region *B*, and N_C pixel triplets, and that the rms value of the residual image is σ. We defined the sum of difference squares for three regions as being

$$\begin{aligned}
\Delta_A &= \sum^{N_A} [I_A(i) - I_A(i')]^2 - 2N_A\sigma^2, \\
\Delta_B &= \sum^{N_B} [I_B(i) - I_B(i')]^2 - 2N_B\sigma^2, \\
\Delta_C &= \sum^{N_C} [I_C(i) - I_A(i') - I_B(i')]^2 - 3N_C\sigma^2.
\end{aligned} \tag{8}$$

Here, $I_A(i) - I_A(i')$ is the residual image difference between a symmetric pixel pair, i and i', in the region *A*; $I_B(i) - I_B(i')$ is that in the region *B*; and $I_C(i) - I_A(i') - I_B(i')$ is that for a pixel in region *C* and its symmetric pixels in regions *A* and *B* (or even *C*). It is necessary to subtract the noise power. We also defined

$$\begin{aligned}
S_A &= \sum^{N_A} [I_A(i) + I_A(i')]^2 - 2N_A\sigma^2, \\
S_B &= \sum^{N_B} [I_B(i) + I_B(i')]^2 - 2N_B\sigma^2, \\
S_C &= \sum^{N_C} [I_C(i) + I_A(i') + I_B(i')]^2 - 3N_C\sigma^2,
\end{aligned} \tag{9}$$

for normalization. Then, the asymmetry factor, *a*, is defined as

$$a = \frac{\Delta_A + \Delta_B + \Delta_C}{S_A + S_B + S_C}. \tag{10}$$

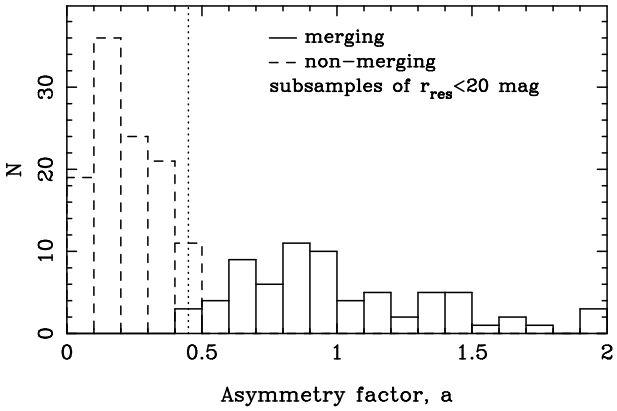

FIG. 5.— Distribution of the asymmetry factors, *a*, for pairs with and without clear interaction features.

Ideally, $a \sim 0$ is for a galaxy pair without any interaction feature. A large *a* means a stronger asymmetric interaction.

By visual inspection on the residual images of all projected pairs, we found 74 pairs with obvious interaction features and 111 pairs clearly without any feature. The magnitude of residual image $r_{\rm res} < 20$ mag and the asymmetry factor $a > 0.45$ can clearly separate the two kinds of pairs, as shown in Figure 5. We then took these criteria to automatically identify the merging pairs from other projected pairs. Note that the asymmetry factor *a* sometimes becomes abnormal when the image of a pair is contaminated by the objects located within $2R_{90}$ of target galaxies. We verified the interaction pairs by a further visual check of such a contamination. Finally, 249 pairs have been identified as merging pairs, which is about 21% of all projected pairs.

2.3. *Pair fraction and merger rate*

Our pair sample can be used to estimate the physical pair fraction and merger rate of luminous early-type galaxies (and SMBHs).

As shown in Figure 6, only about 30%–40% of projected pairs with $7 < r_p < 20$ kpc are mergers. The fraction of mergers among the projected pairs decreases with the projected separation, to $\sim 20\%$ at 30 kpc and 10% at 50 kpc. The fraction can be formulated to be $(0.42 \pm 0.04) - (0.007 \pm 0.001) r_p/{\rm kpc}$. *Previous pair statistics on the merger fraction with the projected pairs should be scaled by these factors.*

Note that there still are galaxy mergers with $r_p < 7$ kpc which likely merge in a shorter timescale, but are not included in our sample. Taking the number in each separation bin at $r_p < 7$ kpc to be the average number between 7 and 20 kpc, we extrapolated another 57 merging pairs with $r_p < 7$ kpc. In total, there should be 306 mergers.

We also checked the distribution of velocity differences for the spec–spec pairs. As shown in Figure 6, the velocity differences for merging pairs roughly follow a Gaussian distribution with a standard deviation of about 134 km s^{-1}. Mergers rarely have $\Delta v > 500$ km s^{-1}.

The pair fraction is defined as the number of galaxies in physical pairs divided by the total number of galaxies (i.e., the number of physical pairs $\times 2$ /the total number of galaxies),

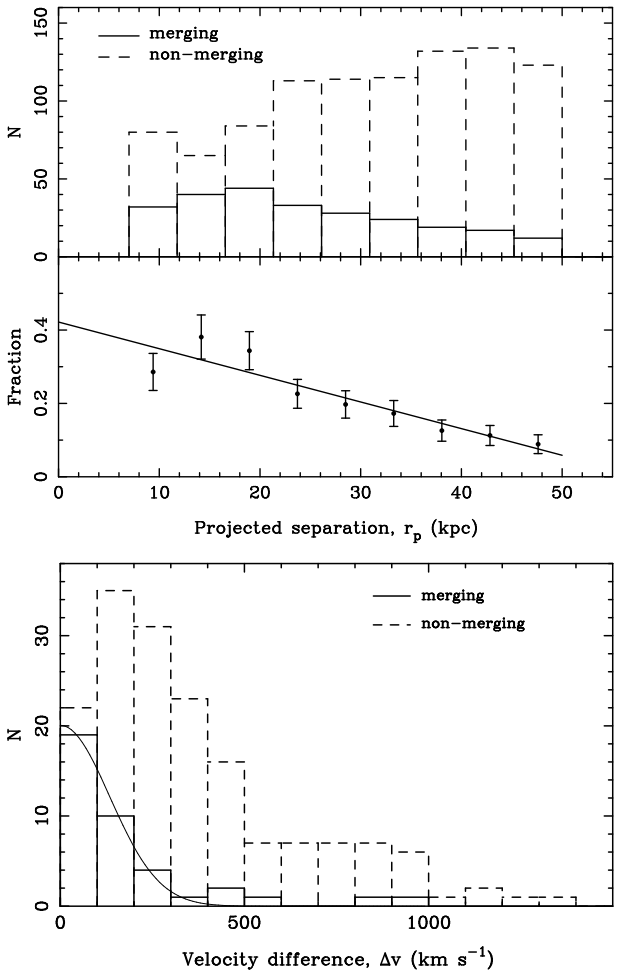

FIG. 6.— Top panel: distribution of the projected separations, r_p, for the merging and nonmerging pairs and the fraction of merging pairs among the projected pairs in each separation bin. *Lower panel*: distribution of velocity differences Δv for the merging and nonmerging pairs in the spec–spec sample. For the mergers, the velocity dispersions have a Gaussian distribution with a standard deviation about 134 km s^{-1}.

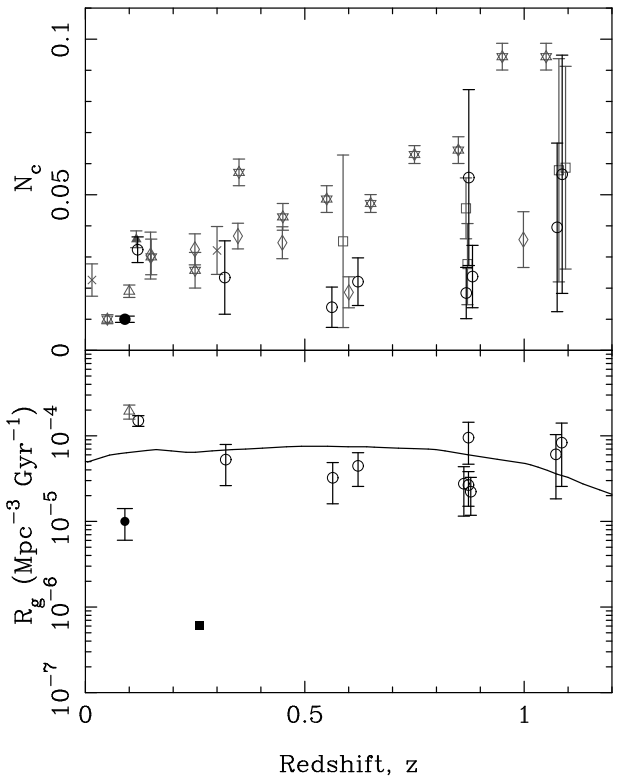

FIG. 7.— The pair fraction we obtained is indicated as the black dot at z = 0.09 and compared with previous statistics of close pairs (*in the upper panel*): gray crosses indicate the values at z = 0.01 from Patton et al. (2000) and at z = 0.3 from Patton et al. (2002), filled gray triangle at z = 0.12 from De Propris et al. (2005), open gray triangle at z = 0.1 from De Propris et al. (2007), gray diamonds from Carlberg et al. (2000), gray stars from Kartaltepe et al. (2007), black circles from Lin et al. (2008). The values for early-type galaxies are marked as black symbols. The merger rate we determined is indicated as the black dot *in the lower panel*, and compared with that from Masjedi et al. (2006) by black square and Lin et al. (2008) by the black circles for dry merger, and De Propris et al. (2007) by gray triangle for general mergers. The solid line is the evolution of the merger rate calculated for dry mergers by Khochfar & Silk (2008) according to the semi-analytical model of galaxy formation.

which is the same as N_c in Section 1.1 if there is no triple system. Including the estimated merging pairs with $r_p < 7$ kpc, we found that *the fraction of galaxies in the merging pairs is 0.6% or 0.8%* if one sets $r_p < 30$ or $r_p < 50$ kpc, respectively. Note that some physical bound pairs are not at the stage of merging and may not show strong interaction signatures; the above-estimated fraction of merging galaxies should be considered as the lower limit of the physical pair fraction.

Previous statistics of close pairs usually utilized $\Delta v < 500$ km s^{-1} as the criteria for sample selection. If we blindly used the projected pairs with $\Delta v < 500$ km s^{-1} (see Figure 1), without identification of merging features, we then got the pair fraction, N_c, is (1.1±0.1)% and (2.2±0.2)% for $7 < r_p < 30$ kpc and $7 < r_p < 50$ kpc, respectively, or (1.0±0.1)% for $5 < r_p < 20$ h^{-1} kpc. The pair fraction is two or three time larger than that determined with identification of merging features, but is consistent with that given by Kartaltepe et al. (2007).

In Figure 7, we have plotted all results on N_c against redshifts found from the literature by statistics of close pairs. All values have been normalized to the selection criteria, $5 < r_p < 20$ h^{-1} kpc and $\Delta v < 500$ km s^{-1} (Patton et al. 2000). Our result is plotted as a black dot at the mean redshift $\langle z \rangle$ = 0.09. The gray cross at redshift z = 0.01 is taken from Patton et al. (2000), and that at redshift z = 0.3 is from Patton et al. (2002); the filled gray triangle at redshift z = 0.12 is from De Propris et al. (2005), and the open gray triangle at redshift z = 0.1 is from De Propris et al. (2007). Carlberg et al. (2000) derived fractions with $r_p \leq 50$ h^{-1} kpc and $\Delta v < 1000$ km s^{-1}. They found that the number of pairs with $r_p \leq 50$ h^{-1} kpc is 3.8 times that with $r_p \leq 20$ h^{-1} kpc. The ratio between the number of pairs with $\Delta v < 500$ km s^{-1} and that with $\Delta v < 1000$ km s^{-1} is 0.9. We normalized the values and showed them as gray diamonds. Kartaltepe et al. (2007) gave the pair fractions with $5 < r_p < 20$ kpc adopting h = 0.7. We corrected their values based on the fact that the pair fraction is roughly proportional to the maximum projected separation (Patton et al. 2000). The normalized values after correction are shown as gray stars. Lin et al. (2004, 2008) studied close pairs with $10 < r_p < 30$, 50, 100 h^{-1} kpc. The values from Lin et al. (2004) are shown as gray squares. Lin et al. (2008) provided pair fractions for different types of pairs. For a direct comparison with our result, the black circles in the upper panel of Figure 7 are the pair fractions

for early-type mergers. The normalized pair fraction from Lin et al. (2008) is 3.2% at redshift $z = 0.12$, three times that of this work.

Now we can estimate the merger rate of luminous early-type galaxies from our sample. The merger rate is defined as the number of merger events per unit time per comoving volume:

$$R_{\rm g}(z) = n(z)C_{\rm mg}/T_{\rm mg}, \quad (11)$$

where $T_{\rm mg}$ is the timescale for a pair to merge, $C_{\rm mg}$ is the fraction of pairs that will merge within $T_{\rm mg}$, and $n(z)$ is the number density of pairs, i.e., the number of pairs divided by the comoving volume. The merging timescale depends on separation, relative velocity, and mass ratios of galaxies. It has always been assumed that the merging pairs will coalesce within some binary orbits. Patton et al. (2000) and Conselice (2006) assumed an average value of 0.5 Gyr for the merging timescale. Bell et al. (2006a) suggested $T_{\rm mg} \sim 0.15 \pm 0.05$ Gyr for massive merging pairs with $r_p < 20$ kpc. Rines et al. (2007) found a merging timescale of ~ 0.11 Gyr for a very luminous merger system, such as CL0958+4702. Here, we adopted an average merging timescale of $0.3^{+0.2}_{-0.1}$ Gyr for the mergers in our sample, which show the distinct interaction features. We further assumed $C_{\rm mg} = 1$ for our merging pairs, as suggested by simulations (Bell et al. 2006a). Based on our sample of merging pairs including 57 pairs with $r_p < 7$ kpc, we found that the number density of merging pairs is $n = 3.1 \times 10^{-6}$ Mpc^{-3} at redshifts $z < 0.12$. Putting these all together, we derived *the comoving volume merger rate*,

$$R_{\rm g} = (1.0 \pm 0.4) \times 10^{-5}\ {\rm Mpc}^{-3}\ {\rm Gyr}^{-1}. \quad (12)$$

The uncertainty mainly depends on the merging timescale.

In the lower panel of Figure 7, we made a comparison of our merger rate with those from the literature. Our merger rate (black dot) is much larger than 6×10^{-7} Mpc^{-3} Gyr^{-1} (filled square) by Masjedi et al. (2006) for the SDSS Luminous Red Galaxies, but much smaller than $\sim 10^{-4}$ Mpc^{-3} Gyr^{-1} (open circles) by Lin et al. (2008) for early-type galaxy pairs in a number of surveys and $5.2 \times 10^{-4}\ h^3$ Mpc^{-3} Gyr^{-1} (gray triangle) by De Propris et al. (2007) for general merger from the Millennium Galaxy Catalog. Based on a semianalytical model of galaxy formation, Khochfar & Silk (2008) found that the merger rate of dry mergers with masses $M > 6.3 \times 10^{10}\ M_\odot$ is almost a constant value of 6×10^{-5} Mpc^{-3} Gyr^{-1} at redshifts $z < 0.8$ (see the line in the lower panel of Figure 7).

The discrepancy probably arises from different magnitude limits for the sample selections. The lower magnitude limit in Lin et al. (2008) is $M_B = -19$, which appears to be one magnitude fainter than the limit in our sample after the color correction of $B-r = 1.2$ (Jester et al. 2005). Given $-23.2 < M_g < -21.2$, after k-corrections to redshift $z = 0.3$, the number density of the SDSS Luminous Red Galaxies in Masjedi et al. (2006) is 10^{-4} Mpc^{-3}, 10% of that for our sample and 4% for the fainter galaxies ($-21 < M_B < -19$) by De Propris et al. (2007) and Lin et al. (2008). Relating the magnitudes of mergers to the masses of mergers (Jiang & Kochanek 2007), we scaled up our merger rate with $M > 4.2 \times 10^{11}\ M_\odot$ by a factor of 5–10 to the value with $M > 6.3 \times 10^{10}\ M_\odot$ according to the cumulative function of merger rate against the mass of the merger (Figure 2 of Khochfar & Silk 2008). In general, our corrected merger rate appears to be in good agreement with that from the model of Khochfar & Silk (2008).

3. SMBH MERGERS IN THE PAIRS AND GRAVITATIONAL WAVE BACKGROUND

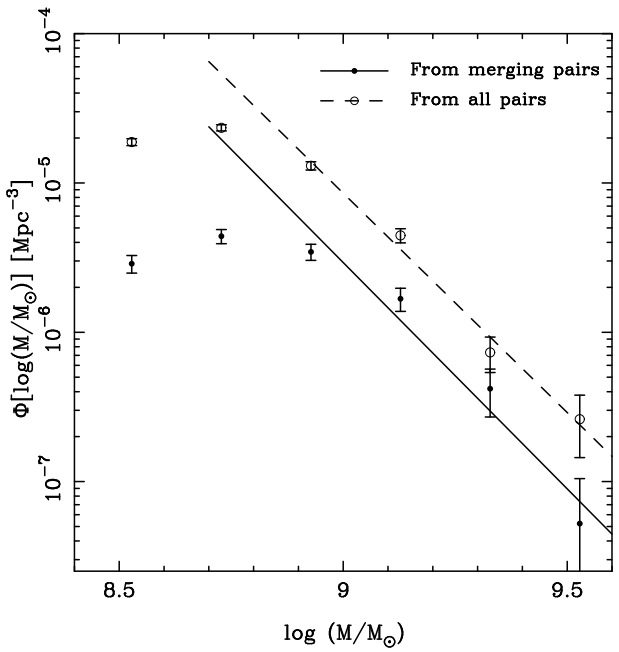

FIG. 8.— The chirp mass distribution of the SMBH binaries in the mergers (filled circle) and all projected pairs (open circle). The lines represent the best fits of power laws.

In the following, we assume that SMBH binaries can be formed in galaxy mergers, and efficiently driven to coalescence with GWs radiation. The detailed physical processes of an SMBH binary shrinking to the GW regime are far from clear (Jaffe & Backer 2003; Sesana et al. 2008a). But very few SMBH binaries have been found in the centers of galaxies (e.g., Owen et al. 1985; Rodriguez et al. 2006), implying that most of the SMBH binaries from galaxy merging must have lost enough momentum and merged in a very short period. A large number of merging-induced coalescences generate a stochastic GW background, which could be a promising GW source to be detected by using pulsar timing measurement.

3.1. *The masses of SMBHs in mergers*

The mass of an SMBH, M, in the center of galaxy is tightly related to the velocity dispersion, σ, the luminosity, L, or the mass of bulge $M_{\rm bulge}$, (Magorrian et al. 1998; Merritt & Ferrarese 2001; McLure & Dunlop 2002; Marconi & Hunt 2003; Häring & Rix 2004). The SMBH mass correlates more tightly with σ than L (Ferrarese & Merritt 2000; Gebhardt et al. 2000). For massive early-type galaxies, however, whether L or σ is a better predictor of the SMBH mass is still an open question. The M–L relation predicts more $10^9\ M_\odot$ SMBHs than the M–σ relation does (Lauer et al. 2007). Recently, Tundo et al. (2007) suggested that the M–σ relation may not follow a single power law. Because of the lack of the velocity dispersions for all pairs, we estimated the masses of SMBHs in mergers using the M–L relation (Tundo et al. 2007)

$$\log M = (8.69 \pm 0.10) - \frac{(1.31 \pm 0.15)}{2.5}(M_r + 22). \quad (13)$$

As stated in Section 2.2, the magnitudes of paired galaxies are taken from the model-fitted values in r band.

From these masses of SMBHs, we determined the chirp masses of the SMBH binaries in the mergers (Eq. 3). We

found that the chirp mass distribution of SMBH binaries (Figure 8) can be fitted with a power law

$$\Phi[\log(M/M_\odot)] = (21.7 \pm 4.2) - (3.0 \pm 0.5)\log M/M_\odot. \quad (14)$$

The two points of low chirp masses were excluded in the fitting because they are underestimated due to the sample selection effect. The magnitude cutoff for galaxies is M_r = –21.5, so that pairs with one galaxy fainter than M_r = –21.5 are missing in our sample.

3.2. *The amplitude of gravitational wave strain*

The spectrum of the GW background from the SMBH mergers can be calculated from the chirp mass distribution and the coalescence rate of a population of SMBH binaries (see Equation 2–7). Based on the newly determined chirp mass distribution and merger rate, we can estimate the amplitude of the GW strain (see Equation 5–7). Recall that (see Section 1.2) no observation-based chirp mass distributions were ever available in any previous calculations.

Another necessary parameter for the estimation of the GW strain is the merger rate evolution index, m. Previous studies (see Section 1.1) have parameterized the merger rate of galaxies as a function of redshift in the form of $(1+z)^m$ with an uncertainty of m in the range of -1 to 3. In the following discussion, we assume that the merger rate of galaxies is equal to that of SMBHs and both evolve in the form of $R(z) \propto (1+z)^m$. We also assume that the chirp mass distribution does not depend on redshift. After putting the local merger rate from Eq.12 and the chirp mass distribution from Eq.14 into Eq. 6, we obtained

$$h_c(f) = 1.1 \times 10^{-15} \left(\frac{f}{\mathrm{yr}^{-1}}\right)^{-2/3} I^{1/2}, \quad (15)$$

in the frequency range of $f \sim 10^{-9}$ to 10^{-7} Hz. Here

$$I = \int \frac{dz}{E(z)(1+z)^{4/3-m}}. \quad (16)$$

The integration between redshift z = 0 and 3 can be simplified as

$$I^{1/2} \approx (0.2m + 0.56)^{3.6} + 0.7, \quad (17)$$

in the range of m = –1 to 4.

For the calculation of $h_c(f)$ above, we considered only the massive mergers. Lower mass systems (i.e., $M_r > -21.5$) is found to add only 1% of the strain amplitude, if the SMBH population at lower mass in Benson et al. (2007) and the merging fraction of this work are considered.

We showed our strain spectrum together with previous estimations in Figure 9. Wyithe & Loeb (2003) calculated the strain spectrum of the GW background with a theoretical model, giving the strain of $(0.5\text{–}0.9)\times10^{-15}(f/\mathrm{yr}^{-1})^{-2/3}$ for different initial parameters of the model (see their Figure 6). The amplitude corresponds to the evolution index m in the range of –3.6 to 0 according to the local merger rate and the SMBH population in this work. The amplitudes obtained by Sesana et al. (2004) and Enoki et al. (2004) correspond to the indices m = 1.5 and m = 0.9, respectively. Jaffe & Backer (2003) quoted the pair fraction from Carlberg et al. (2000) and the SMBH population transformed from Ferguson & Sandage (1991). They showed that the GW background is dominated by the systems of $\sim 10^8\ M_\odot$. Thus, the GW strain amplitude they estimated is a few times lower than this work and others (Wyithe & Loeb 2003; Sesana et al. 2004; Enoki et al. 2004).

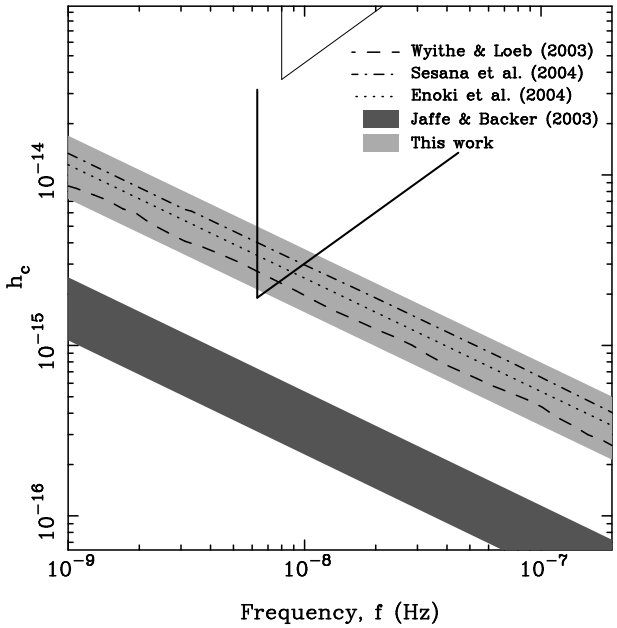

FIG. 9.— Strain spectrum of the stochastic GW background calculated in the range of m = –1 to 2 using Eq.15 (light gray area). The strain spectrum obtained by Jaffe & Backer (2003) is shown as the dark gray area, which was calculated with a different merger rate and SMBH population. The strain spectrum obtained by Wyithe & Loeb (2003) is shown as the dashed line, by Sesana et al. (2004) as dot-dashed line, and by Enoki et al. (2004) as the dotted line. The upper thin solid and lower thick solid lines represent the upper limit of GWs constrained by using available pulsar-timing data sets and simulated data sets of the complete PPTA (Jenet et al. 2006).

The strain amplitude we estimated is comparable to the GW detection sensitivity of the pulsar timing project. Using currently available pulsar timing data sets, one can place the upper limit of the GW background strain or the GW energy density. The GW energy density per unit logarithmic frequency interval can be written as (Phinney 2001)

$$\Omega(f) = \frac{2\pi^2}{3H_0^2} f^2 h_c(f)^2. \quad (18)$$

Using the eight year timing data of PSR B1855+09, Kaspi et al. (1994) obtained $\Omega h^2 < 6 \times 10^{-8}$ for the cosmic GW background. Using the 17 year data of this object, Lommen (2002) got $\Omega(f)h^2 < 2 \times 10^{-9}$. Jenet et al. (2006) developed a new technique to place better limits using the available pulsar-timing data sets in the Parks pulsar-timing array (PPTA) project (Hobbs 2005; Manchester 2006) and the simulation data sets (20 pulsars with rms timing residual of 100 ns over five years) of the future complete PPTA. They derived the upper limits of the GW background emitted from the SMBH coalescence to be $1.1 \times 10^{-14}(f/\mathrm{yr}^{-1})^{-2/3}$ and $6.5 \times 10^{-16}(f/\mathrm{yr}^{-1})^{-2/3}$ for the available data of the PPTA and the complete PPTA, respectively. The upper limit from the available pulsar-timing data corresponds to an index m = 5.8, which is not very meaningful from our knowledge of the evolution of the galaxy merger rate. The complete PPTA data in future could limit the index m to –1.6.

4. CONCLUSIONS

Previously almost all calculations for GW background have been derived from the theoretical models of galaxy mergers and simulations, with the merger rate or/and SMBH mass function "calibrated" by the observed values. Jaffe & Backer

(2003) have directly used the observed galaxy merger rate and the SMBH mass function for this purpose. However, when deriving the merger rate from projected galaxy pairs, very few previous authors have carefully checked the merging fraction of a large sample of pairs. Normally, the merging conditions were set as projected separations $r_p < 20\ h^{-1}$ kpc and the radial velocity differences $\Delta v < 500$ km s^{-1}, which are certainly necessary but not sufficient conditions.

We have made a careful selection of a large complete volume-limited sample of projected close pairs ($r_p < 50$ kpc) of luminous early-type galaxies ($M_r < -21.5$) in the local universe ($z < 0.12$) from the SDSS photometric and spectroscopic data. 71% of the pairs have $\Delta v < 500$ km s^{-1}, and 21% of the pairs show merging features. Considering the total number of all luminous early-type galaxies, we found that 0.8% of the galaxies are merging. From the merging pairs, we derived a comoving volume merger rate of $\sim (1.0 \pm 0.4) \times 10^{-5}$ Mpc^{-3} Gyr^{-1} for luminous early-type galaxies. This is a direct observational determination of the merger rate of luminous galaxies in the local universe. Our merger rate is larger than that derived from the SDSS Luminous Red Galaxies (Masjedi et al. 2006).

For the first time, from the identified merging pairs of a complete sample of luminous early-type galaxies, we found that the chirp mass distribution of SMBH binaries can be described by a power law. With less assumptions than previous authors, we obtained the strain amplitude of the GW background from coalescence of SMBH binaries in frequency range 10^{-9}–10^{-7} Hz, $h_c(f) \sim 10^{-15}(f/\mathrm{yr}^{-1})^{-2/3}$. The uncertainty of the GW background estimation now mainly comes from poor knowledge on the merger rate evolution, the SMBH population and unknown processes for an SMBH binary to be driven into the GW regime.

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TABLE 1 A LIST OF LUMINOUS EARLY-TYPE GALAXY PAIRS FROM THE SDSS DR6

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	r_{res} (12)	z (13)	z-flag (14)	Comments (15)
1	0.21881	16.09328	0.22045	16.08902	16.41	16.88	-22.58	-21.51	33.06	0.25	20.28	0.1145	sp	non-merging
2	0.98566	-10.35133	0.99133	-10.34565	15.45	15.77	-22.36	-23.42	42.75	1.47	19.68	0.0813	sp	merging
3	1.40038	15.93645	1.40021	15.94040	16.17	16.94	-22.53	-21.54	28.83	1.10	20.01	0.1148	sp	non-merging
4	1.40742	16.22732	1.40505	16.22976	16.86	17.01	-21.64	-21.23	23.36	0.26	20.56	0.1095	sp	non-merging
5	1.91387	0.69263	1.91320	0.68826	15.95	17.00	-23.01	-21.88	32.05	1.64	18.83	0.1141	sp	merging
6	2.23632	14.29741	2.23641	14.29035	15.84	15.94	-21.86	-22.36	35.97	0.00	20.47	0.0767	sp	non-merging
7	3.35190	0.91775	3.35490	0.91536	16.56	16.98	-22.57	-21.98	25.94	0.00	20.48	0.1053	sp	non-merging
8	3.37760	0.67847	3.37124	0.67352	15.68	16.30	-22.11	-21.73	44.69	0.17	19.06	0.0843	sp	non-merging
9	4.93503	14.69997	4.93721	14.69631	16.25	16.80	-22.54	-21.92	30.56	0.35	20.15	0.1138	sp	non-merging
10	5.11466	-1.06926	5.11096	-1.06093	14.89	15.13	-22.34	-22.31	39.33	0.11	18.14	0.0641	sp	non-merging
11	5.63937	15.66189	5.64412	15.65961	16.07	16.24	-22.25	-22.15	31.03	0.12	19.44	0.0932	sp	non-merging
12	5.90701	-0.50983	5.90740	-0.50313	14.60	15.22	-22.76	-21.91	28.64	0.54	18.09	0.0633	sp	non-merging
13	9.99985	-0.83541	10.00260	-0.83504	16.46	16.47	-21.56	-21.80	17.25	0.49	19.69	0.0958	ph	merging
14	10.37679	-9.23520	10.37010	-9.23295	15.09	15.20	-21.79	-21.88	26.06	0.10	19.65	0.0549	sp	non-merging
15	11.45771	-0.85029	11.45170	-0.85429	15.10	16.68	-23.03	-21.77	46.68	0.19	18.77	0.1002	ph	non-merging
16	11.75564	15.49433	11.75559	15.50159	15.69	15.14	-22.52	-23.27	42.94	0.26	18.81	0.0906	ph	non-merging
17	12.75385	-9.24832	12.75936	-9.24475	16.17	17.31	-22.95	-21.43	49.08	0.20	20.03	0.1194	sp	non-merging
18	14.04813	0.68198	14.03857	0.68703	14.86	15.24	-22.79	-22.45	48.86	0.26	19.34	0.0674	sp	non-merging
19	17.13711	1.14977	17.13195	1.14773	15.28	16.08	-22.97	-22.43	36.12	0.21	19.20	0.1010	sp	non-merging
20	18.31536	15.51646	18.31752	15.50293	13.76	14.85	-22.92	-21.94	42.92	0.25	17.87	0.0456	sp	non-merging
21	19.09798	-9.79236	19.09950	-9.79126	16.52	17.15	-22.22	-21.58	13.86	0.08	19.31	0.1182	sp	non-merging
22	20.98766	-9.68549	20.99348	-9.68064	15.97	16.28	-22.66	-22.35	49.68	0.38	19.95	0.1027	sp	non-merging
23	22.72287	-9.80059	22.72483	-9.79554	16.08	16.55	-22.67	-22.42	40.51	1.40	20.33	0.1186	sp	non-merging
24	23.72383	-0.66498	23.72326	-0.66025	15.03	15.45	-23.30	-23.16	27.59	0.08	18.37	0.0884	ph	non-merging
25	25.51844	-1.19095	25.51387	-1.19309	16.23	16.62	-22.70	-21.99	36.61	0.77	19.47	0.1142	ph	non-merging
26	28.28454	1.03074	28.29036	1.03342	15.47	15.97	-22.07	-21.59	29.84	0.24	19.62	0.0696	ph	non-merging
27	28.97733	14.82157	28.97191	14.82765	15.78	16.35	-22.17	-21.87	45.88	0.78	19.48	0.0872	ph	non-merging
28	31.12088	-8.73961	31.11648	-8.73530	16.96	16.99	-21.64	-21.64	44.52	2.12	21.53	0.1144	sp	non-merging
29	31.54962	-0.02374	31.55377	-0.02527	16.12	16.48	-22.90	-22.52	31.82	0.97	17.77	0.1130	sp	merging
30	33.51605	13.31312	33.52108	13.31098	14.99	15.04	-22.49	-22.46	21.71	0.65	17.93	0.0600	sp	non-merging
31	35.64083	-8.64268	35.64368	-8.64809	15.88	17.10	-22.51	-21.50	42.92	0.63	21.14	0.1102	sp	non-merging
32	37.17765	-0.84925	37.17604	-0.84648	15.60	16.41	-22.11	-21.40	17.98	0.74	18.65	0.0854	sp	merging
33	44.73899	0.78820	44.74554	0.79232	15.65	16.21	-22.30	-22.03	45.68	0.05	19.08	0.0904	sp	non-merging
34	45.35049	-0.13371	45.34399	-0.13828	15.36	16.18	-23.03	-21.95	45.31	0.02	19.61	0.0869	sp	non-merging
35	46.21550	0.74302	46.21706	0.73624	16.39	17.15	-22.44	-21.93	49.81	0.02	19.89	0.1124	ph	non-merging
36	49.26715	0.02908	49.26955	0.02562	16.46	17.10	-22.40	-21.31	30.71	0.33	20.13	0.1147	sp	non-merging
37	50.29210	-0.22152	50.28910	-0.21441	15.62	15.88	-21.69	-21.56	34.41	0.14	19.25	0.0664	sp	non-merging
38	50.93086	-0.11842	50.92233	-0.11701	14.20	14.31	-22.84	-22.79	32.26	0.31	18.21	0.0548	sp	non-merging
39	110.66376	41.47858	110.67033	41.47609	15.51	16.05	-22.91	-22.16	31.72	0.41	18.02	0.0878	sp	non-merging
40	111.26754	37.91758	111.26173	37.91546	15.68	16.50	-22.63	-21.51	30.16	0.24	19.73	0.0915	ph	non-merging
41	111.30663	41.51642	111.30441	41.51728	15.66	15.73	-22.83	-22.24	10.36	0.43	20.71	0.0841	ph	non-merging
42	111.48654	42.02265	111.49931	42.01668	15.22	15.35	-21.70	-21.48	44.16	0.19	18.24	0.0581	sp	non-merging
43	111.85040	27.75626	111.85225	27.75609	15.79	16.13	-22.74	-22.23	11.27	0.45	19.51	0.1071	ph	merging
44	112.00343	41.91878	112.01781	41.92406	14.42	14.98	-22.56	-21.97	42.21	0.37	17.74	0.0518	ph	non-merging
45	112.23046	44.23700	112.23430	44.23473	16.77	16.94	-21.92	-21.59	25.40	0.30	19.84	0.1116	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
46	114.12271	18.87839	114.13050	18.88047	15.77	16.13	-22.52	-22.30	45.28	0.00	19.18	0.0906	ph	non-merging
47	114.25641	17.74125	114.26326	17.74309	14.53	15.16	-22.63	-22.18	28.85	0.38	18.40	0.0632	ph	non-merging
48	114.50109	23.98120	114.50901	23.98170	14.72	16.07	-23.33	-21.54	39.06	0.02	18.86	0.0816	sp	non-merging
49	114.52977	34.09011	114.53236	34.09187	16.13	16.29	-22.60	-22.11	19.27	0.61	19.53	0.1090	sp	merging
50	115.10049	24.16343	115.10607	24.15864	16.27	16.11	-21.72	-22.16	40.17	0.61	20.53	0.0877	sp	non-merging
51	115.28099	16.00217	115.27953	15.99629	15.16	15.93	-23.32	-22.81	40.02	0.28	19.32	0.1028	ph	non-merging
52	115.68969	48.83737	115.68546	48.83633	16.28	16.68	-21.93	-22.93	18.44	0.11	19.65	0.0957	sp	non-merging
53	115.70877	43.76482	115.71305	43.75856	15.94	16.06	-22.09	-21.72	38.45	0.32	19.70	0.0836	sp	non-merging
54	115.72028	43.29455	115.72245	43.28977	16.53	16.77	-22.11	-22.15	35.91	0.61	21.18	0.1119	sp	non-merging
55	115.96288	28.35399	115.96355	28.35778	16.99	16.10	-21.90	-22.82	26.13	2.55	20.21	0.1063	sp	non-merging
56	116.09492	34.09407	116.09689	34.08958	16.65	16.82	-21.89	-21.47	31.80	0.71	20.23	0.1036	sp	non-merging
57	116.18040	16.92258	116.17652	16.92735	15.20	15.91	-22.46	-21.87	30.00	0.96	18.97	0.0747	ph	merging
58	116.67855	30.99707	116.68906	31.00322	14.92	15.07	-22.54	-22.20	43.02	1.05	17.75	0.0582	sp	merging
59	116.92912	18.12484	116.92398	18.12900	16.54	16.74	-22.04	-21.92	46.36	0.29	19.98	0.1135	sp	non-merging
60	117.82729	37.66808	117.83033	37.65964	15.49	16.22	-22.44	-21.71	48.46	0.22	19.98	0.0839	sp	non-merging
61	117.86516	37.29269	117.86565	37.28809	15.57	16.50	-22.74	-22.07	29.74	0.43	20.23	0.0996	ph	non-merging
62	117.88491	51.57005	117.87780	51.57025	15.96	16.04	-22.30	-21.83	25.66	0.20	18.94	0.0886	sp	non-merging
63	118.02887	23.48302	118.02177	23.48097	13.61	15.05	-23.36	-21.56	22.34	0.29	18.18	0.0477	ph	non-merging
64	118.04770	28.38872	118.05055	28.38984	15.86	16.68	-22.61	-21.67	18.61	0.17	19.63	0.1056	ph	non-merging
65	118.62560	51.12144	118.63568	51.12129	15.66	16.45	-22.75	-21.95	40.30	0.13	20.27	0.0984	sp	non-merging
66	118.71468	45.70506	118.70421	45.71532	14.79	15.07	-22.15	-21.76	44.42	0.15	19.35	0.0516	sp	non-merging
67	118.86058	36.68310	118.85745	36.69144	15.64	15.82	-22.19	-22.77	44.49	0.20	18.82	0.0770	sp	non-merging
68	118.96212	33.73674	118.95909	33.73991	15.72	16.04	-22.54	-21.99	23.88	0.45	18.71	0.0903	ph	merging
69	119.25403	37.41601	119.26228	37.41619	16.82	16.97	-21.64	-21.35	43.99	0.45	20.98	0.1044	ph	non-merging
70	119.35300	39.35185	119.35056	39.34656	16.27	16.57	-23.93	-22.90	40.59	0.00	20.51	0.1137	ph	non-merging
71	119.79153	29.78105	119.79682	29.78431	15.74	15.75	-22.73	-22.65	38.08	0.39	19.05	0.1052	sp	non-merging
72	120.51778	44.01096	120.52102	44.00681	15.32	15.94	-22.81	-22.00	23.79	0.22	19.05	0.0752	sp	non-merging
73	121.19361	52.47711	121.19443	52.47395	16.04	16.13	-22.21	-21.63	17.86	0.51	19.81	0.0851	sp	non-merging
74	121.66537	32.77965	121.66352	32.77810	16.98	17.06	-21.76	-22.40	15.85	0.40	19.71	0.1133	sp	non-merging
75	121.75188	2.20135	121.74686	2.19989	14.59	14.83	-22.43	-21.97	18.58	0.32	18.08	0.0521	ph	non-merging
76	121.80421	9.15741	121.80314	9.16008	15.43	16.09	-23.33	-22.60	18.44	1.98	18.01	0.0994	ph	merging
77	122.05376	55.13973	122.06140	55.14212	15.81	16.11	-22.34	-22.00	26.88	1.07	18.78	0.0819	sp	merging
78	122.10049	7.25807	122.10116	7.26371	15.72	15.89	-22.75	-22.55	36.40	0.42	19.99	0.0992	sp	non-merging
79	122.18108	14.78920	122.17892	14.79305	15.65	16.21	-23.30	-21.66	24.63	0.00	20.67	0.0855	sp	non-merging
80	122.66195	16.52132	122.66086	16.52800	16.43	16.77	-21.86	-21.56	43.20	0.18	19.93	0.0989	sp	non-merging
81	122.77106	2.02630	122.76895	2.02291	15.99	16.44	-21.76	-21.55	22.12	1.66	19.62	0.0843	ph	merging
82	122.89326	16.65341	122.89202	16.64836	15.90	16.41	-22.11	-21.56	30.93	0.19	19.55	0.0915	sp	non-merging
83	123.07919	6.57254	123.08025	6.57522	16.01	17.01	-22.80	-21.42	20.22	1.68	19.21	0.1099	sp	merging
84	123.47778	41.40096	123.47312	41.39782	15.93	16.44	-23.29	-22.09	30.40	0.00	21.18	0.1001	sp	non-merging
85	124.06006	11.46703	124.05664	11.47123	16.64	16.70	-21.86	-21.56	32.80	1.20	20.18	0.0939	ph	non-merging
86	124.48553	42.88068	124.48854	42.87653	15.28	16.35	-22.63	-21.51	24.83	0.25	19.42	0.0799	sp	non-merging
87	124.54527	33.19489	124.54861	33.19295	15.60	15.98	-22.58	-22.33	19.79	0.20	18.83	0.0891	sp	non-merging
88	124.62803	56.60901	124.62729	56.59970	14.42	15.27	-22.69	-21.72	36.44	0.25	17.90	0.0576	ph	non-merging
89	124.71051	22.95807	124.70674	22.95455	15.37	15.65	-22.58	-22.33	29.61	0.73	18.97	0.0920	sp	merging
90	125.20155	51.29141	125.19238	51.28593	15.83	16.27	-22.21	-21.74	42.38	0.56	20.32	0.0810	sp	non-merging
91	125.39222	23.20803	125.38687	23.21331	15.95	16.80	-22.69	-21.59	46.20	0.88	20.07	0.0991	ph	non-merging
92	125.76074	17.70616	125.75912	17.70625	16.24	16.35	-22.16	-21.62	9.02	0.67	18.42	0.0890	sp	merging
93	125.77983	3.56523	125.77569	3.57004	15.66	16.25	-22.51	-21.79	35.69	0.24	19.21	0.0858	sp	non-merging
94	125.79160	4.33752	125.78609	4.33486	15.93	16.59	-22.10	-21.64	37.43	0.13	19.46	0.0942	sp	non-merging
95	125.97701	15.58609	125.97324	15.58365	16.07	16.48	-22.04	-22.18	26.33	0.40	20.17	0.0924	sp	non-merging
96	126.00117	15.57964	125.99931	15.57898	15.65	15.99	-23.01	-23.20	11.56	0.16	18.70	0.0934	sp	non-merging
97	126.27836	25.90078	126.27119	25.90072	14.79	15.06	-22.98	-22.78	36.52	0.34	18.19	0.0863	sp	non-merging
98	126.34727	7.47212	126.35082	7.47392	16.11	16.46	-22.41	-22.13	24.70	0.06	19.75	0.0962	sp	non-merging
99	126.53017	4.45671	126.52925	4.45582	16.80	17.04	-21.86	-21.48	8.60	2.33	21.56	0.1049	sp	non-merging
100	126.54024	17.89866	126.54292	17.89597	15.87	16.57	-22.28	-21.79	22.06	0.87	18.13	0.0910	sp	merging
101	126.54913	2.59755	126.54597	2.59729	14.12	15.24	-22.85	-21.70	11.54	0.31	18.35	0.0533	ph	non-merging
102	127.00367	28.26439	127.00274	28.26818	15.62	16.34	-23.36	-21.95	24.31	0.33	20.07	0.0967	ph	non-merging
103	127.01608	54.77650	127.01367	54.77644	15.52	16.75	-22.84	-21.65	9.04	0.19	18.69	0.1006	ph	non-merging
104	127.10951	17.92355	127.10995	17.93086	15.75	15.88	-22.23	-22.13	42.03	0.25	19.81	0.0875	sp	non-merging
105	127.32933	29.18650	127.33218	29.18932	15.81	16.62	-22.39	-21.61	22.89	0.33	19.55	0.0935	sp	non-merging
106	127.37049	39.10965	127.37398	39.10487	15.91	16.08	-22.40	-22.15	33.18	0.45	20.69	0.0929	sp	non-merging
107	127.52077	53.35234	127.51485	53.35605	16.41	16.95	-22.05	-21.93	37.43	0.49	19.56	0.1150	sp	merging
108	127.84265	40.53281	127.84215	40.53593	16.03	16.87	-22.39	-21.90	20.44	0.34	19.58	0.1006	sp	non-merging
109	127.89011	61.23846	127.88964	61.23278	15.85	16.10	-23.08	-22.86	42.01	0.60	20.33	0.1167	ph	non-merging
110	127.95118	17.12318	127.95363	17.12872	15.63	17.01	-23.05	-21.50	42.78	0.05	19.56	0.1117	sp	non-merging
111	128.05176	51.98317	128.06085	51.98684	16.19	17.03	-22.27	-21.87	47.19	0.30	19.03	0.1104	sp	non-merging
112	128.26353	13.80872	128.26588	13.81196	16.74	16.97	-21.73	-21.55	26.51	0.32	22.00	0.1040	sp	non-merging
113	129.07884	22.93158	129.07457	22.93081	16.87	17.06	-21.74	-21.65	28.34	0.30	21.37	0.1108	sp	non-merging
114	129.13167	24.80796	129.12717	24.81171	16.01	17.02	-22.66	-21.65	39.71	0.12	19.89	0.1124	sp	non-merging
115	129.19121	47.36947	129.18678	47.37191	14.89	15.05	-21.94	-21.64	13.90	1.01	17.78	0.0527	sp	merging
116	129.24095	8.91931	129.24323	8.91977	16.28	17.18	-22.41	-21.57	16.73	1.10	20.39	0.1149	sp	non-merging
117	129.58505	35.42463	129.58685	35.42751	15.84	16.83	-22.73	-21.86	22.77	0.70	20.08	0.1102	sp	non-merging
118	129.58585	1.73254	129.58286	1.73616	15.61	16.03	-21.84	-21.28	22.20	0.21	19.73	0.0708	ph	non-merging
119	129.71815	33.20741	129.71646	33.20872	15.45	15.93	-22.19	-21.50	9.02	0.62	18.41	0.0697	sp	merging
120	129.74701	26.13700	129.74416	26.13818	15.10	16.04	-22.60	-21.68	14.23	0.29	20.46	0.0760	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
121	129.74889	36.22123	129.75523	36.21785	14.91	15.23	-22.02	-21.64	23.31	0.27	18.71	0.0558	sp	non-merging
122	130.01978	25.01494	130.02257	25.00952	15.32	15.66	-22.32	-21.99	28.16	0.18	19.20	0.0704	sp	non-merging
123	130.04100	9.00143	130.04382	8.99811	14.98	15.63	-22.90	-22.03	18.67	0.59	18.45	0.0639	sp	non-merging
124	130.04474	17.69134	130.04517	17.69657	15.55	15.72	-22.24	-21.82	25.15	0.52	19.00	0.0718	sp	non-merging
125	130.12247	17.24069	130.12479	17.24189	16.63	17.02	-21.86	-21.52	18.25	2.75	20.30	0.1139	sp	non-merging
126	130.14296	22.22696	130.14323	22.22427	16.47	16.99	-22.36	-21.64	18.45	0.56	20.66	0.1066	ph	non-merging
127	130.16248	28.53036	130.15570	28.52296	15.88	16.05	-22.59	-21.85	49.95	0.00	20.78	0.0796	sp	non-merging
128	130.24301	18.10057	130.24512	18.10422	15.75	17.22	-23.18	-21.86	31.04	0.39	19.95	0.1178	sp	non-merging
129	130.26137	59.93630	130.27251	59.94662	13.85	14.56	-23.20	-22.24	37.82	0.58	17.66	0.0469	ph	merging
130	130.31041	7.52698	130.31631	7.52877	16.53	16.68	-22.43	-21.72	40.61	0.16	20.32	0.1031	sp	non-merging
131	130.45667	26.71607	130.46060	26.71321	15.41	15.61	-22.53	-22.32	25.29	0.92	19.01	0.0848	sp	merging
132	130.65239	18.20410	130.64975	18.20710	16.00	16.18	-22.65	-22.31	26.51	0.43	18.80	0.1058	sp	non-merging
133	131.02574	37.01287	131.02747	37.00657	16.18	16.59	-22.63	-22.03	45.49	0.07	18.91	0.1107	sp	non-merging
134	131.10994	30.63399	131.11269	30.63685	15.67	15.80	-22.51	-22.83	21.92	0.19	20.66	0.0905	sp	non-merging
135	131.22591	27.72000	131.22496	27.71900	15.65	15.76	-21.94	-22.90	7.25	0.23	18.39	0.0846	sp	non-merging
136	131.73187	3.01202	131.73068	3.01316	16.49	17.02	-22.28	-21.60	11.26	0.47	20.77	0.1062	sp	non-merging
137	131.86781	33.86581	131.85876	33.86856	15.56	15.62	-22.24	-22.43	39.91	0.41	17.43	0.0750	sp	non-merging
138	131.94252	24.91429	131.94423	24.91283	15.98	16.46	-22.29	-21.45	11.97	0.35	18.69	0.0857	sp	non-merging
139	132.16145	33.22305	132.16707	33.21964	16.84	17.01	-21.53	-21.65	40.18	0.24	20.58	0.1082	sp	non-merging
140	132.52954	29.54777	132.53198	29.54915	14.98	15.21	-24.22	-23.24	17.10	0.07	18.69	0.1051	sp	non-merging
141	132.54471	51.77541	132.54498	51.77693	15.59	16.29	-22.57	-21.70	8.88	0.27	20.19	0.0888	sp	non-merging
142	132.63025	24.32670	132.62762	24.33299	16.09	16.89	-23.43	-22.11	47.76	0.00	20.14	0.1112	sp	non-merging
143	132.65720	58.17002	132.66432	58.16977	16.80	17.02	-22.18	-21.93	28.16	0.69	19.90	0.1181	ph	non-merging
144	132.69113	40.17925	132.68947	40.17846	16.17	16.28	-21.94	-21.78	8.38	0.54	20.72	0.0851	sp	non-merging
145	132.86636	34.40837	132.86424	34.40964	16.51	16.94	-22.29	-21.74	16.05	0.70	20.61	0.1172	sp	non-merging
146	133.06599	29.71424	133.06873	29.71327	15.75	16.83	-22.64	-22.76	17.06	0.53	19.38	0.1035	sp	merging
147	133.35242	43.81549	133.35652	43.81959	15.03	16.39	-23.32	-21.41	29.75	0.62	18.61	0.0901	sp	merging
148	133.50453	40.22861	133.49930	40.22905	15.34	16.34	-23.01	-21.53	23.12	0.80	19.03	0.0878	sp	non-merging
149	133.65253	0.64257	133.64847	0.64088	15.00	16.91	-23.51	-21.70	29.67	0.02	19.14	0.1051	sp	non-merging
150	133.70166	49.31262	133.69748	49.31750	16.23	17.00	-22.56	-22.07	41.71	0.08	20.58	0.1178	sp	non-merging
151	133.76860	25.76303	133.76837	25.76412	16.80	17.18	-22.21	-21.82	8.02	2.09	20.76	0.1132	sp	non-merging
152	133.83266	36.42502	133.82860	36.41715	16.19	16.45	-22.02	-21.43	48.91	0.40	19.78	0.0876	sp	non-merging
153	133.89679	40.46482	133.90009	40.45771	14.89	15.90	-23.00	-22.11	42.86	0.44	19.06	0.0867	sp	non-merging
154	134.33788	16.72231	134.33730	16.71418	16.05	15.89	-22.35	-22.25	49.99	1.10	19.58	0.0943	ph	non-merging
155	134.54465	7.46830	134.54791	7.46246	15.99	16.71	-22.06	-21.40	41.49	0.53	20.07	0.0958	sp	non-merging
156	134.62184	14.21790	134.61864	14.21538	16.54	16.67	-21.57	-21.47	25.78	1.15	19.70	0.0997	sp	merging
157	134.63344	38.49323	134.63129	38.50122	15.66	16.54	-23.23	-21.89	48.87	0.19	17.92	0.0917	sp	non-merging
158	134.74422	38.32488	134.73746	38.32694	15.83	15.87	-22.13	-22.15	33.57	0.13	19.39	0.0903	sp	non-merging
159	134.84915	45.09668	134.85356	45.09348	16.27	16.48	-22.15	-21.46	25.15	0.05	19.67	0.0858	sp	non-merging
160	134.96338	36.58857	134.95775	36.58767	16.03	16.33	-22.16	-22.07	31.21	0.22	19.12	0.1055	sp	non-merging
161	134.97676	39.43858	134.97452	39.44123	15.81	16.65	-22.45	-21.54	19.67	0.17	19.42	0.0955	sp	non-merging
162	135.05333	17.55359	135.05409	17.55103	14.94	15.63	-22.53	-21.56	11.11	0.23	18.37	0.0620	ph	non-merging
163	135.24092	62.62392	135.23250	62.63039	15.65	16.32	-22.83	-22.08	48.27	0.18	19.96	0.0990	ph	non-merging
164	135.48088	32.59885	135.48422	32.60481	15.90	16.48	-22.59	-22.13	41.24	0.25	20.38	0.0965	sp	non-merging
165	135.64543	20.73831	135.64862	20.74142	15.38	15.94	-22.75	-22.10	23.64	0.35	19.06	0.0834	sp	non-merging
166	135.83490	1.95019	135.83035	1.95251	16.82	16.96	-21.95	-21.83	38.16	0.72	21.61	0.1183	sp	non-merging
167	136.10590	51.71699	136.10957	51.71434	15.97	16.45	-23.19	-22.10	26.07	0.21	18.92	0.1178	ph	non-merging
168	136.16905	13.94929	136.16148	13.94828	15.63	16.57	-23.15	-22.02	49.05	0.69	19.85	0.1028	ph	non-merging
169	136.40771	14.49562	136.40526	14.49991	16.85	16.92	-21.90	-21.72	36.74	0.83	21.06	0.1184	sp	non-merging
170	136.60785	36.88330	136.60597	36.88523	16.46	16.67	-22.32	-21.96	16.86	0.31	19.82	0.1079	sp	non-merging
171	136.87378	62.22032	136.86810	62.21672	15.34	16.87	-23.15	-21.55	29.23	0.39	18.83	0.1015	ph	non-merging
172	136.94252	52.77824	136.95396	52.78093	16.16	16.72	-22.20	-22.04	47.08	0.73	20.44	0.0979	sp	non-merging
173	136.98473	49.59673	136.99091	49.60267	14.10	14.75	-22.93	-22.49	23.39	1.92	16.57	0.0475	ph	merging
174	137.06424	16.04214	137.06880	16.04124	15.42	15.94	-22.55	-21.85	23.33	0.75	19.34	0.0787	ph	non-merging
175	137.57903	2.18960	137.57855	2.18860	16.17	16.59	-22.68	-21.56	7.09	0.34	19.39	0.0999	sp	non-merging
176	137.60652	56.66156	137.61110	56.66350	16.07	16.85	-22.35	-21.48	21.11	0.46	19.00	0.1033	sp	merging
177	137.84338	12.80183	137.84506	12.79864	16.42	16.87	-23.11	-21.64	25.90	0.00	20.80	0.1136	ph	non-merging
178	138.09203	48.98441	138.09619	48.98477	16.20	17.22	-22.83	-21.47	20.46	0.88	20.48	0.1172	sp	non-merging
179	138.11757	16.58565	138.12282	16.58545	16.07	16.21	-21.92	-22.16	29.45	0.11	19.12	0.0895	sp	non-merging
180	138.65160	36.27273	138.65547	36.27317	16.62	16.93	-21.77	-21.71	22.57	1.49	20.46	0.1123	sp	non-merging
181	138.71910	15.74226	138.71390	15.74472	14.41	16.03	-23.13	-21.60	26.08	0.61	18.69	0.0698	ph	merging
182	139.18279	18.95459	139.17262	18.96346	13.51	13.95	-22.23	-21.64	26.80	0.30	15.82	0.0292	sp	non-merging
183	139.39561	40.33668	139.40160	40.33809	16.09	16.60	-22.24	-21.97	28.98	0.26	20.58	0.0933	sp	non-merging
184	139.41402	15.39254	139.41164	15.38923	15.29	16.10	-22.68	-21.88	20.91	0.71	19.16	0.0783	sp	merging
185	139.59744	14.94238	139.59804	14.94113	15.95	16.62	-22.07	-21.36	8.10	2.24	20.10	0.0900	ph	non-merging
186	139.69928	14.96507	139.69673	14.96474	15.84	16.24	-22.14	-21.71	14.32	0.44	19.80	0.0880	sp	non-merging
187	140.20337	40.66422	140.20032	40.66483	15.65	15.82	-23.03	-21.76	11.59	0.65	19.84	0.0727	sp	merging
188	140.33214	15.88163	140.33669	15.88157	15.49	17.01	-23.41	-21.89	30.47	0.26	19.12	0.1089	sp	non-merging
189	140.41570	13.50000	140.41899	13.50694	15.49	16.09	-22.11	-21.38	38.53	0.37	18.64	0.0759	ph	non-merging
190	141.10451	21.24452	141.10522	21.24752	16.26	16.74	-22.15	-21.48	20.51	0.79	19.87	0.1038	sp	non-merging
191	141.24782	65.46616	141.25677	65.47219	13.68	14.76	-22.60	-21.59	21.07	0.31	17.40	0.0430	ph	non-merging
192	141.59007	8.23304	141.59053	8.23910	16.95	17.03	-21.66	-21.96	43.37	0.21	22.05	0.1120	ph	non-merging
193	142.09668	10.55925	142.09610	10.56467	15.27	16.01	-22.89	-22.00	32.24	0.60	19.38	0.0906	sp	merging
194	142.21466	2.20561	142.21675	2.20608	16.09	16.16	-22.33	-21.93	12.88	0.35	19.45	0.0923	sp	non-merging
195	142.24135	2.14061	142.24672	2.13676	16.89	16.93	-21.89	-21.60	49.83	0.26	19.85	0.1194	sp	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
196	142.36868	-1.34943	142.36549	-1.34578	15.83	16.06	-22.68	-22.92	34.79	1.17	18.68	0.1129	ph	merging
197	142.44666	21.44242	142.43280	21.43398	14.02	14.24	-22.26	-21.77	37.49	0.60	17.71	0.0349	ph	merging
198	143.07056	9.68359	143.07135	9.67918	14.43	15.41	-23.47	-22.33	23.37	0.39	18.97	0.0790	sp	non-merging
199	143.07660	-2.20533	143.07816	-2.20720	16.72	16.79	-22.03	-21.76	17.69	0.00	20.14	0.1145	ph	non-merging
200	143.83522	0.10570	143.83212	0.10759	15.89	16.48	-22.28	-21.66	21.22	0.23	20.27	0.0893	sp	non-merging
201	143.87625	9.27139	143.87332	9.27304	15.76	17.10	-23.12	-22.18	25.08	0.98	19.33	0.1193	sp	merging
202	144.11823	14.70590	144.11888	14.70720	15.14	15.40	-22.59	-22.07	7.37	0.26	19.47	0.0768	ph	non-merging
203	144.78273	39.59029	144.79103	39.58997	16.46	16.74	-22.02	-21.75	44.53	0.54	20.52	0.1087	sp	non-merging
204	144.97995	16.78497	144.98898	16.78690	14.21	14.90	-22.43	-21.70	29.50	1.36	17.86	0.0485	sp	merging
205	146.10983	3.05582	146.11400	3.05492	15.14	16.27	-22.81	-21.75	23.58	0.91	18.63	0.0843	ph	merging
206	146.28760	60.54617	146.28178	60.53884	16.08	16.65	-22.34	-21.66	46.90	1.34	19.55	0.0913	sp	non-merging
207	146.53717	2.34479	146.54138	2.34428	16.69	16.97	-22.16	-21.80	31.94	0.63	22.60	0.1192	sp	non-merging
208	146.54720	2.37246	146.54990	2.36882	16.32	16.39	-22.73	-23.12	33.90	0.06	19.93	0.1183	sp	non-merging
209	146.81592	53.82394	146.82411	53.82202	14.54	15.06	-22.74	-22.11	20.61	0.28	17.00	0.0584	ph	non-merging
210	147.19344	4.93930	147.19699	4.94161	15.67	16.58	-22.75	-21.39	25.13	0.36	19.68	0.0912	sp	non-merging
211	147.26532	1.60530	147.27065	1.60504	15.53	16.06	-22.59	-22.23	33.13	0.39	19.87	0.0958	sp	non-merging
212	147.46564	13.78437	147.46837	13.78297	16.95	17.02	-21.75	-21.80	22.35	0.38	20.44	0.1177	ph	non-merging
213	147.71716	58.67197	147.72762	58.67477	15.96	16.46	-22.98	-22.17	44.80	1.18	18.82	0.1155	sp	merging
214	147.76735	6.08275	147.76637	6.07641	16.20	16.21	-22.21	-22.13	42.15	0.22	20.30	0.1020	ph	non-merging
215	147.95348	12.00318	147.94788	12.00356	17.01	17.06	-21.72	-21.79	39.42	0.81	21.18	0.1128	sp	non-merging
216	148.05157	1.16795	148.04668	1.17890	15.37	15.66	-21.80	-21.40	49.77	0.22	18.60	0.0615	sp	non-merging
217	148.45284	57.17358	148.46631	57.17859	15.60	16.25	-22.66	-22.12	47.49	0.52	19.06	0.0812	sp	non-merging
218	148.74628	32.62197	148.73624	32.61992	15.29	15.95	-23.56	-22.12	47.34	0.85	19.42	0.0825	sp	non-merging
219	148.79100	39.00203	148.78761	38.99990	16.33	16.85	-22.25	-21.70	25.03	0.18	18.89	0.1168	sp	non-merging
220	148.80376	0.28482	148.80333	0.27653	15.57	16.20	-22.75	-21.98	47.72	0.77	18.90	0.0878	sp	merging
221	148.90564	56.04742	148.89949	56.04821	16.48	16.62	-22.93	-22.47	26.04	0.31	20.07	0.1166	sp	non-merging
222	148.91449	1.59678	148.91769	1.59733	16.12	16.84	-22.77	-22.06	20.74	0.87	18.55	0.0986	sp	merging
223	149.04303	1.19207	149.04254	1.19609	16.41	16.50	-22.25	-22.17	28.43	0.58	20.43	0.1099	sp	non-merging
224	149.05908	16.05264	149.05518	16.05707	16.09	16.31	-22.00	-21.73	33.58	0.30	20.51	0.0882	ph	non-merging
225	149.14977	-2.57636	149.15022	-2.57916	15.65	16.27	-22.65	-21.92	17.02	0.18	19.74	0.0921	ph	non-merging
226	149.20103	20.08002	149.20117	20.07455	15.26	15.51	-22.48	-22.02	28.60	0.34	17.78	0.0790	sp	non-merging
227	149.20323	-1.36279	149.20175	-1.36198	16.43	16.43	-21.78	-22.01	10.60	1.07	21.12	0.0968	ph	non-merging
228	149.47038	36.34925	149.47162	36.34651	14.06	14.54	-22.35	-21.57	7.87	0.60	18.34	0.0388	sp	merging
229	149.76369	16.18982	149.75745	16.18667	15.34	15.59	-22.42	-21.95	34.31	0.37	18.43	0.0764	ph	non-merging
230	149.83765	1.29774	149.83653	1.29859	15.16	15.49	-23.43	-23.22	8.99	0.02	19.74	0.0994	sp	non-merging
231	149.89464	28.55594	149.89746	28.55321	16.45	16.58	-21.58	-21.47	21.51	0.14	19.90	0.0892	sp	non-merging
232	149.92380	3.03249	149.91922	3.02769	15.77	16.30	-22.25	-21.98	35.11	0.36	19.14	0.0801	sp	non-merging
233	150.58595	17.85921	150.59064	17.86127	16.64	16.79	-21.68	-21.69	30.78	0.22	20.13	0.0966	sp	non-merging
234	150.61505	55.92289	150.60892	55.92020	15.94	16.02	-22.36	-22.23	26.97	0.69	19.85	0.0951	sp	merging
235	150.64940	10.86392	150.65288	10.86573	15.36	16.25	-22.86	-21.42	20.11	0.02	18.79	0.0785	sp	non-merging
236	150.88773	31.53806	150.89375	31.53763	16.66	16.94	-21.95	-21.64	34.75	0.85	20.08	0.1049	sp	non-merging
237	150.99643	15.97506	150.99811	15.97152	16.82	16.83	-22.17	-21.74	27.16	0.30	20.53	0.1093	ph	non-merging
238	151.24179	3.52470	151.23590	3.52224	16.23	16.41	-22.26	-21.84	43.03	0.75	19.82	0.1052	sp	non-merging
239	151.27608	9.45642	151.27774	9.45500	17.21	17.27	-21.80	-21.56	16.35	0.17	21.09	0.1192	sp	non-merging
240	151.40297	29.28324	151.40480	29.28182	15.75	16.42	-23.18	-22.10	13.06	0.54	18.39	0.0939	sp	merging
241	151.44485	18.12663	151.44153	18.12386	15.54	15.77	-22.02	-22.04	21.78	0.24	18.42	0.0782	sp	non-merging
242	151.44592	2.24662	151.44608	2.24413	14.25	14.81	-22.42	-22.04	7.85	0.58	18.75	0.0456	sp	merging
243	151.48759	18.34304	151.48488	18.34459	15.37	15.62	-22.52	-22.12	15.19	0.40	18.67	0.0761	ph	non-merging
244	151.59338	30.22582	151.59648	30.22027	15.82	16.25	-23.05	-22.59	45.21	0.23	19.22	0.1156	sp	non-merging
245	151.81738	20.96932	151.81285	20.96414	15.36	16.09	-22.90	-22.43	47.68	0.46	18.27	0.1119	sp	non-merging
246	151.95984	0.53184	151.95992	0.53442	15.88	16.68	-22.95	-21.98	18.75	0.16	19.79	0.1142	ph	non-merging
247	152.06935	15.84566	152.06061	15.84468	14.59	15.93	-23.29	-21.92	46.90	0.32	17.94	0.0842	ph	non-merging
248	152.15808	17.26629	152.16203	17.26459	16.18	16.56	-22.49	-22.01	29.55	0.34	20.00	0.1120	ph	non-merging
249	152.27097	39.28482	152.26822	39.28211	15.56	15.86	-21.89	-21.67	15.84	0.97	18.76	0.0686	sp	merging
250	152.50458	18.21167	152.49835	18.20979	15.79	16.34	-23.64	-22.71	46.07	0.52	18.89	0.1172	sp	merging
251	152.79689	19.24203	152.78865	19.24040	15.50	16.33	-22.47	-21.85	44.87	0.23	20.05	0.0860	sp	non-merging
252	152.97223	19.54406	152.96477	19.53783	15.00	15.68	-22.63	-21.95	42.57	0.29	18.87	0.0676	sp	non-merging
253	153.44344	19.76384	153.43832	19.76190	15.59	17.01	-23.19	-22.00	37.15	0.22	18.52	0.1124	sp	non-merging
254	153.51559	14.52421	153.50905	14.53364	14.46	14.78	-21.94	-21.49	32.41	0.06	17.36	0.0412	ph	non-merging
255	153.52081	20.87484	153.52588	20.87634	15.24	16.09	-23.41	-22.67	34.33	0.40	18.72	0.1081	sp	non-merging
256	153.53546	44.17575	153.53279	44.17677	16.17	17.00	-22.46	-21.87	15.68	0.83	18.99	0.1134	sp	merging
257	153.59422	18.30320	153.59856	18.30852	16.43	16.52	-22.27	-22.42	49.38	0.47	19.93	0.1157	ph	non-merging
258	153.61662	-0.90313	153.62170	-0.90541	14.83	16.73	-23.38	-21.54	35.38	0.08	18.10	0.0981	sp	non-merging
259	153.61839	-1.28403	153.61902	-1.29009	15.06	15.06	-22.08	-22.09	25.14	0.33	18.23	0.0610	ph	non-merging
260	153.85094	60.14226	153.84671	60.14210	15.77	16.11	-22.03	-21.69	10.23	1.53	18.42	0.0727	sp	merging
261	153.88766	44.22456	153.89522	44.22418	15.48	15.99	-22.26	-21.58	25.19	0.84	19.23	0.0694	sp	merging
262	154.04259	19.75414	154.04558	19.75286	15.33	16.15	-22.86	-21.95	16.05	1.11	17.37	0.0783	sp	merging
263	154.07970	56.79455	154.06660	56.79110	14.73	15.24	-22.84	-22.12	36.32	0.28	18.32	0.0681	ph	non-merging
264	154.47508	0.32243	154.47374	0.32250	16.38	16.61	-22.53	-21.91	8.41	0.00	21.82	0.0965	sp	non-merging
265	154.60826	2.53952	154.61235	2.54114	16.10	16.66	-22.12	-21.88	29.47	0.55	19.03	0.1044	ph	merging
266	154.67435	6.82166	154.67287	6.82255	16.75	16.81	-21.70	-21.59	11.24	0.41	20.50	0.1016	sp	non-merging
267	154.76680	3.51127	154.77071	3.51360	16.71	16.96	-21.98	-22.37	33.50	0.62	20.44	0.1164	sp	non-merging
268	154.81134	43.32489	154.81744	43.32648	17.25	17.25	-21.62	-21.71	35.10	0.00	22.77	0.1176	sp	non-merging
269	154.92674	14.73053	154.92978	14.72792	16.78	16.78	-21.72	-21.85	27.84	0.44	21.67	0.1111	ph	non-merging
270	154.94031	40.99413	154.93280	40.98857	16.00	16.17	-23.10	-22.03	46.69	0.38	19.63	0.0901	sp	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
271	155.13448	-2.55234	155.13220	-2.55068	15.76	16.31	-22.11	-21.67	15.12	0.30	19.94	0.0815	ph	non-merging
272	155.14636	-2.46836	155.13371	-2.47315	14.10	14.27	-22.56	-22.46	42.25	0.05	17.65	0.0454	ph	non-merging
273	155.29297	47.13363	155.29843	47.14103	15.27	15.36	-21.99	-22.04	35.06	0.35	18.60	0.0627	sp	non-merging
274	155.54169	38.52322	155.54298	38.51782	14.32	14.70	-22.55	-22.23	19.84	0.47	18.29	0.0530	sp	merging
275	155.55255	17.85966	155.55362	17.85379	14.58	14.77	-22.12	-21.89	19.61	0.26	17.66	0.0479	ph	non-merging
276	155.56932	14.90796	155.56572	14.91606	14.65	15.23	-22.34	-21.67	32.04	0.32	17.80	0.0533	ph	non-merging
277	155.60457	7.37995	155.60114	7.37597	15.85	17.25	-22.96	-21.55	39.49	0.49	20.59	0.1193	sp	non-merging
278	155.63248	2.36080	155.63234	2.35387	14.98	15.66	-22.61	-21.75	32.94	0.34	19.29	0.0712	sp	non-merging
279	155.70570	49.98793	155.71024	49.99340	16.51	17.16	-22.37	-21.81	45.48	0.34	19.21	0.1155	sp	non-merging
280	155.79570	7.65705	155.79213	7.65750	15.88	16.96	-22.86	-21.84	26.63	0.17	20.11	0.1180	ph	non-merging
281	155.84427	8.86697	155.83475	8.86349	14.89	15.25	-22.98	-22.01	42.32	0.00	19.45	0.0625	sp	non-merging
282	155.86276	10.60351	155.85588	10.61576	14.59	14.89	-21.84	-21.71	42.30	0.12	18.50	0.0438	sp	non-merging
283	155.91942	37.39125	155.91248	37.39045	16.30	16.49	-22.49	-22.21	38.78	0.30	19.90	0.1088	sp	non-merging
284	155.97382	36.88895	155.96719	36.88461	15.99	16.58	-22.24	-21.48	42.03	0.28	19.62	0.0943	sp	non-merging
285	156.18181	10.43651	156.18109	10.43084	15.48	16.84	-23.51	-22.25	42.31	0.88	18.97	0.1167	sp	merging
286	156.43782	58.93709	156.43753	58.93863	16.88	17.26	-21.94	-21.53	11.53	0.30	20.38	0.1180	sp	non-merging
287	156.49744	21.44839	156.50107	21.44919	16.47	16.77	-22.15	-22.19	24.86	0.55	20.50	0.1123	sp	non-merging
288	156.85414	5.82790	156.85144	5.83287	16.62	16.89	-21.92	-21.66	39.30	0.30	20.09	0.1088	sp	non-merging
289	156.90318	-3.06618	156.89769	-3.05522	14.71	14.75	-21.80	-21.77	37.55	0.32	18.42	0.0444	ph	non-merging
290	156.95535	45.01717	156.94499	45.01284	16.18	16.44	-21.79	-21.61	49.68	0.34	20.22	0.0892	ph	non-merging
291	156.98862	10.59236	156.98482	10.58900	16.48	16.82	-22.09	-21.66	35.37	0.52	20.67	0.1103	sp	non-merging
292	157.07217	14.48603	157.07397	14.49240	16.35	16.78	-22.63	-21.91	47.03	0.00	19.70	0.1116	ph	non-merging
293	157.08282	6.72697	157.07834	6.72495	15.82	17.25	-23.02	-23.03	36.04	0.00	20.32	0.1162	sp	non-merging
294	157.09782	3.75874	157.09518	3.76454	14.77	15.55	-23.21	-22.29	28.44	0.79	17.37	0.0665	ph	merging
295	157.22066	11.86222	157.21960	11.86721	16.51	16.52	-22.09	-21.98	35.99	0.23	20.41	0.1108	sp	non-merging
296	157.25522	20.16838	157.25601	20.17435	16.06	16.50	-22.70	-22.05	42.58	0.92	17.94	0.1110	sp	merging
297	157.32986	0.97278	157.32608	0.97399	15.96	16.42	-22.07	-21.49	23.12	0.19	20.28	0.0890	sp	non-merging
298	157.55132	-0.84360	157.55266	-0.84341	16.57	17.16	-22.24	-21.56	9.92	0.32	20.77	0.1152	sp	non-merging
299	157.60454	38.35608	157.60175	38.35520	15.66	16.41	-23.03	-22.22	16.77	0.77	20.66	0.1115	sp	non-merging
300	157.62415	43.24222	157.62823	43.24382	15.74	15.93	-22.57	-22.47	21.75	0.14	18.63	0.0996	sp	non-merging
301	157.81828	11.15202	157.81905	11.14903	15.23	15.34	-22.17	-21.96	13.36	0.66	19.88	0.0645	sp	merging
302	157.87228	35.91473	157.87328	35.91864	15.91	16.20	-21.99	-21.80	23.12	0.36	20.43	0.0885	sp	non-merging
303	157.93623	35.01700	157.93274	35.01839	16.86	17.14	-22.39	-21.89	23.17	0.00	21.16	0.1147	ph	non-merging
304	157.98236	58.11652	157.99084	58.11354	15.52	16.67	-23.06	-21.99	32.87	0.42	18.72	0.0939	sp	non-merging
305	158.01054	64.17492	158.01636	64.17823	16.65	16.78	-22.29	-22.04	30.94	0.14	18.88	0.1172	sp	non-merging
306	158.05209	40.29068	158.04501	40.28415	15.52	16.33	-22.06	-21.45	44.97	0.18	18.07	0.0802	sp	non-merging
307	158.18800	52.42535	158.19278	52.41549	14.92	15.84	-22.58	-21.42	45.45	0.61	18.59	0.0658	sp	merging
308	158.54036	4.35826	158.53775	4.35855	15.59	16.33	-23.36	-21.99	16.92	0.77	18.00	0.1001	sp	merging
309	159.10710	1.03395	159.11221	1.02979	15.62	16.79	-23.26	-21.76	49.38	0.18	20.30	0.1185	sp	non-merging
310	159.11038	44.73046	159.11066	44.73546	16.22	16.61	-22.59	-21.62	29.76	0.00	21.09	0.0913	sp	non-merging
311	159.13545	36.07704	159.12868	36.07476	15.79	16.63	-22.48	-22.19	44.78	0.34	19.15	0.1195	sp	non-merging
312	159.18433	10.65892	159.18370	10.65783	16.74	17.13	-21.91	-21.60	9.11	0.40	21.45	0.1142	sp	non-merging
313	159.57753	40.09141	159.57352	40.08858	16.56	16.83	-22.34	-22.00	30.79	0.76	20.56	0.1165	sp	non-merging
314	159.67206	12.05928	159.67720	12.05434	15.92	16.02	-22.09	-22.27	42.21	0.43	19.75	0.0918	sp	non-merging
315	159.73849	49.80596	159.73730	49.80143	16.74	17.08	-21.73	-21.59	32.35	0.29	20.38	0.1101	sp	non-merging
316	159.83113	2.32177	159.83928	2.32213	15.47	16.26	-22.96	-21.70	44.79	0.07	19.33	0.0835	sp	non-merging
317	160.36140	31.80398	160.35513	31.80396	17.12	17.21	-21.72	-21.31	39.20	0.48	20.50	0.1160	sp	non-merging
318	160.42957	57.46350	160.42584	57.46352	16.74	17.19	-22.03	-21.59	15.04	0.32	20.21	0.1188	sp	non-merging
319	160.52274	-1.40797	160.52182	-1.40680	16.51	16.66	-21.61	-21.99	9.73	0.41	20.25	0.1018	ph	non-merging
320	160.63815	0.93323	160.64301	0.93706	15.66	16.60	-23.32	-21.95	45.31	0.85	18.73	0.1155	sp	merging
321	160.67616	10.42544	160.67558	10.43073	16.42	16.55	-22.66	-22.13	34.46	0.14	20.54	0.1002	sp	non-merging
322	160.69501	-1.84316	160.69113	-1.84877	16.15	16.48	-22.40	-22.12	48.00	0.02	19.61	0.1104	ph	non-merging
323	160.79745	48.64437	160.79449	48.64153	16.79	17.12	-22.48	-21.87	25.44	0.00	21.01	0.1162	sp	non-merging
324	160.93758	23.65439	160.93414	23.65528	14.51	16.14	-23.19	-21.50	17.17	0.32	18.43	0.0795	ph	non-merging
325	160.96648	1.06169	160.96689	1.06324	15.97	16.45	-22.71	-22.23	11.88	1.37	20.09	0.1169	sp	non-merging
326	161.31596	-2.90347	161.32356	-2.90343	15.40	15.65	-21.93	-21.69	32.38	0.16	18.36	0.0633	ph	non-merging
327	161.38702	1.38821	161.38445	1.38981	15.94	16.91	-22.55	-21.62	20.37	0.18	19.30	0.1046	sp	non-merging
328	161.41238	17.96873	161.41638	17.97526	16.38	16.46	-21.61	-21.40	42.80	0.29	19.38	0.0863	ph	non-merging
329	161.61285	-3.24492	161.61176	-3.24464	16.65	16.75	-21.64	-22.04	7.25	1.00	18.62	0.0992	ph	non-merging
330	161.83134	31.66071	161.83008	31.65625	15.37	16.94	-23.64	-22.10	33.55	0.02	19.70	0.1152	sp	non-merging
331	162.03690	31.47285	162.03653	31.47526	15.90	15.70	-22.67	-24.64	17.93	0.60	19.57	0.1163	sp	non-merging
332	162.05942	31.54605	162.05434	31.54570	16.87	17.18	-22.06	-21.67	31.89	0.58	21.27	0.1157	sp	non-merging
333	162.23038	31.32923	162.22562	31.32688	15.54	16.53	-23.35	-22.39	34.81	0.40	19.55	0.1170	sp	non-merging
334	162.35690	1.01134	162.35959	1.01160	15.51	16.26	-23.00	-22.47	18.47	0.35	19.38	0.1068	sp	non-merging
335	162.73264	29.86151	162.73187	29.85612	15.88	16.92	-23.17	-21.98	41.03	0.62	20.39	0.1195	sp	non-merging
336	163.30125	19.02841	163.29829	19.03184	16.38	16.63	-22.24	-21.76	29.29	0.43	20.46	0.1028	ph	non-merging
337	163.49251	23.12759	163.49170	23.12859	15.54	16.43	-23.04	-21.69	7.76	0.24	18.97	0.0958	ph	non-merging
338	164.12105	-2.32537	164.12189	-2.32614	16.00	16.74	-22.21	-21.61	7.38	0.02	19.93	0.1005	ph	non-merging
339	164.16414	7.12236	164.16660	7.12332	16.09	16.58	-22.39	-21.65	17.76	0.60	19.60	0.1057	sp	merging
340	164.28287	40.58369	164.27953	40.58931	16.41	16.81	-23.08	-22.06	46.08	0.42	18.63	0.1181	sp	non-merging
341	164.30446	8.28308	164.30495	8.28710	16.80	16.98	-22.03	-21.91	29.69	0.60	19.41	0.1155	ph	merging
342	164.42000	57.89549	164.42287	57.89888	16.88	16.94	-21.99	-21.62	26.86	0.74	20.19	0.1137	sp	non-merging
343	164.54910	-1.91516	164.54938	-1.91134	16.33	16.92	-22.38	-21.47	28.59	1.04	18.99	0.1181	ph	merging
344	164.55435	1.60687	164.54578	1.60458	14.41	13.53	-22.05	-22.86	25.59	0.24	18.28	0.0417	ph	non-merging
345	164.78587	40.03185	164.79790	40.02998	15.11	15.40	-21.87	-21.65	36.68	0.30	18.34	0.0575	sp	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
346	164.79234	7.80913	164.78781	7.81470	15.95	15.98	-22.24	-22.30	49.07	0.35	18.56	0.1070	sp	non-merging
347	164.84155	21.09895	164.85037	21.09390	16.14	16.22	-21.68	-21.60	49.35	0.31	18.91	0.0771	ph	non-merging
348	164.85500	14.81842	164.85951	14.81391	16.16	16.54	-21.96	-21.25	36.14	0.14	19.76	0.0879	sp	non-merging
349	164.99455	8.95598	164.99646	8.95992	14.97	15.49	-22.55	-21.65	18.18	0.08	18.79	0.0617	sp	non-merging
350	165.04829	5.92840	165.04886	5.93392	16.34	16.91	-22.06	-21.32	37.73	0.45	20.11	0.1059	sp	non-merging
351	165.66008	29.25704	165.65338	29.25175	15.03	15.90	-22.56	-21.65	37.84	0.22	19.15	0.0719	sp	non-merging
352	165.73682	65.48073	165.74202	65.48154	16.78	17.13	-21.91	-21.60	16.75	0.55	20.73	0.1143	sp	non-merging
353	166.24350	2.31895	166.24701	2.31760	16.23	16.58	-22.25	-21.87	24.43	0.58	19.84	0.1007	sp	non-merging
354	166.30002	30.07590	166.29921	30.07748	15.22	15.98	-22.66	-21.54	8.32	0.24	18.48	0.0719	sp	non-merging
355	166.55949	9.05593	166.55849	9.06517	16.03	16.14	-21.60	-21.50	45.67	0.06	21.09	0.0739	sp	non-merging
356	166.66096	-0.75839	166.66000	-0.75629	16.94	17.17	-21.71	-21.25	16.48	0.50	20.94	0.1121	sp	non-merging
357	166.67355	42.81168	166.67412	42.82206	14.49	15.44	-22.75	-22.00	41.49	0.83	17.80	0.0590	sp	merging
358	166.73256	46.10345	166.73380	46.10282	16.90	17.05	-22.01	-21.69	7.61	0.84	19.87	0.1127	sp	merging
359	166.75058	38.58876	166.74519	38.59259	16.25	16.27	-22.42	-22.46	39.12	1.08	20.98	0.1074	sp	non-merging
360	166.82359	15.86335	166.81981	15.86105	15.23	16.62	-23.24	-21.56	25.70	0.02	18.19	0.0915	sp	non-merging
361	166.89670	61.30482	166.89487	61.30381	17.12	17.13	-21.39	-21.94	10.15	0.72	19.93	0.1195	sp	merging
362	166.97217	8.94227	166.96796	8.94530	15.15	16.55	-23.53	-21.79	34.91	0.00	19.34	0.1056	sp	non-merging
363	167.03194	26.01715	167.03925	26.02155	15.27	15.70	-22.44	-22.03	38.06	0.28	19.17	0.0721	sp	non-merging
364	167.06837	8.92535	167.06213	8.92238	15.08	16.26	-23.56	-22.21	45.91	0.60	18.54	0.1044	sp	merging
365	167.09740	32.01479	167.08467	32.00582	14.55	14.87	-22.20	-21.66	46.05	0.28	17.85	0.0478	sp	non-merging
366	167.37447	60.38092	167.37007	60.38274	15.33	15.89	-22.64	-21.85	15.05	1.10	19.48	0.0804	sp	merging
367	167.39853	50.70632	167.39751	50.70125	16.16	16.96	-22.59	-21.61	37.83	0.29	19.88	0.1168	sp	non-merging
368	167.51208	1.67134	167.51060	1.67199	15.76	16.46	-23.17	-21.85	10.72	0.07	19.32	0.1031	sp	non-merging
369	167.72340	10.53044	167.72487	10.53166	15.58	15.97	-21.68	-22.12	8.69	1.15	19.22	0.0686	sp	merging
370	167.78993	39.59778	167.80161	39.59720	14.48	15.17	-23.35	-22.72	46.01	0.27	17.90	0.0769	sp	non-merging
371	167.83609	38.11025	167.83914	38.10751	16.60	16.91	-22.35	-21.40	23.76	0.00	20.41	0.1012	sp	non-merging
372	167.86383	2.95052	167.85994	2.95423	16.91	16.96	-21.72	-21.55	36.68	0.29	20.87	0.1064	sp	non-merging
373	168.27283	14.02179	168.26672	14.02228	16.63	16.94	-22.44	-21.68	44.11	0.12	19.85	0.1172	sp	non-merging
374	168.33385	2.54667	168.33904	2.54430	14.59	14.84	-23.78	-23.46	32.51	0.70	17.92	0.0870	ph	non-merging
375	168.42204	24.45451	168.42213	24.45591	16.47	16.74	-22.47	-21.66	9.75	0.16	20.10	0.1084	ph	non-merging
376	168.60910	45.15337	168.61061	45.15051	16.80	17.04	-21.89	-21.56	21.54	0.75	19.09	0.1107	sp	merging
377	168.74495	-0.13940	168.74069	-0.14164	16.31	16.38	-22.27	-22.17	31.48	0.18	19.23	0.1015	sp	non-merging
378	168.80287	0.59007	168.80379	0.59285	15.55	16.21	-22.18	-21.53	15.03	0.88	19.29	0.0774	sp	merging
379	168.86917	31.79880	168.86896	31.79996	15.81	16.65	-23.41	-21.84	8.84	1.28	19.58	0.1185	sp	merging
380	168.87535	8.35332	168.88054	8.35627	16.04	16.50	-22.53	-22.01	42.40	0.33	20.44	0.1124	ph	non-merging
381	169.00052	3.47070	168.99648	3.46328	15.83	16.21	-21.95	-21.38	43.39	0.25	19.97	0.0775	sp	non-merging
382	169.14423	29.25477	169.14597	29.24967	14.45	14.62	-22.48	-22.20	18.22	0.40	18.90	0.0500	sp	non-merging
383	169.15143	2.32393	169.15283	2.31768	15.63	15.99	-22.11	-21.49	33.42	0.91	18.82	0.0787	ph	merging
384	169.21138	45.28036	169.21326	45.27388	16.52	16.59	-22.01	-22.04	47.23	0.09	20.10	0.1122	sp	non-merging
385	169.22243	23.84669	169.22055	23.84544	15.07	16.68	-23.19	-21.74	13.57	0.26	18.58	0.0988	ph	non-merging
386	169.23265	2.78975	169.23047	2.79368	16.33	16.70	-22.11	-21.52	29.65	0.24	20.20	0.1023	sp	non-merging
387	169.37686	50.64024	169.37430	50.64301	16.51	16.84	-22.08	-21.76	22.77	0.46	20.22	0.1115	ph	non-merging
388	169.48694	34.88493	169.48463	34.89218	15.76	16.44	-22.83	-21.80	47.42	1.18	19.08	0.0977	sp	merging
389	169.49191	8.38730	169.48483	8.38610	16.78	16.91	-21.73	-21.60	49.76	0.43	20.94	0.1096	ph	non-merging
390	169.53902	45.61869	169.54228	45.62018	16.28	16.36	-22.65	-22.13	19.27	0.26	19.39	0.1109	sp	non-merging
391	169.60475	50.59161	169.59601	50.59689	15.85	16.32	-22.66	-22.14	47.68	0.49	19.92	0.0959	sp	non-merging
392	169.88274	50.46138	169.88760	50.45897	16.68	16.77	-21.63	-21.65	26.92	0.21	20.22	0.1070	sp	non-merging
393	169.93311	13.96392	169.93480	13.96290	14.76	15.83	-22.88	-21.37	8.78	0.76	19.85	0.0678	sp	merging
394	170.04410	54.60565	170.04248	54.60860	15.84	16.00	-21.61	-21.52	14.60	0.27	19.75	0.0705	sp	non-merging
395	170.13571	53.80202	170.14127	53.80291	16.54	16.73	-21.80	-21.51	21.98	0.14	20.17	0.1001	sp	non-merging
396	170.38568	2.88725	170.39709	2.89382	14.11	14.57	-22.68	-22.38	44.04	0.30	18.03	0.0488	sp	non-merging
397	170.39767	35.39022	170.40242	35.38724	15.46	15.77	-23.29	-22.90	31.76	0.81	19.22	0.1007	ph	non-merging
398	170.40811	4.62620	170.40616	4.62595	15.13	15.24	-22.00	-22.23	8.78	0.63	19.01	0.0666	ph	merging
399	170.47552	26.08927	170.47397	26.08995	15.90	16.72	-22.85	-21.59	10.19	0.36	19.55	0.1016	sp	non-merging
400	170.62091	50.01904	170.62347	50.01268	15.58	17.16	-23.27	-21.55	47.82	0.55	20.01	0.1145	sp	non-merging
401	170.63974	63.07684	170.63094	63.07487	16.92	17.04	-21.57	-21.54	31.55	0.62	21.62	0.1113	sp	non-merging
402	170.68698	0.46227	170.68507	0.46014	15.55	16.26	-22.74	-22.08	18.55	3.21	19.41	0.1006	sp	merging
403	170.84868	19.58164	170.84821	19.57775	16.88	16.91	-21.84	-21.56	26.45	0.05	19.77	0.1053	ph	non-merging
404	170.88217	26.42203	170.88895	26.41833	15.54	15.60	-21.97	-22.10	29.20	0.36	18.97	0.0608	sp	non-merging
405	171.11374	48.87941	171.10739	48.88059	15.15	15.91	-23.58	-22.40	29.31	1.01	19.04	0.1052	sp	non-merging
406	171.33069	59.94125	171.32742	59.94086	16.28	16.91	-22.59	-21.48	12.08	0.39	20.21	0.1130	sp	non-merging
407	171.54054	25.34423	171.53944	25.34350	16.36	16.50	-22.00	-23.16	8.57	0.57	21.58	0.1088	ph	non-merging
408	171.87964	20.17025	171.87457	20.17347	15.95	16.56	-22.61	-22.11	41.52	0.35	19.93	0.1137	ph	non-merging
409	172.23053	47.09985	172.22488	47.09767	16.34	16.68	-22.32	-21.93	29.63	0.31	20.26	0.1044	sp	non-merging
410	172.24371	-2.81820	172.23779	-2.82156	16.22	16.34	-22.06	-21.77	40.12	0.34	18.83	0.0903	ph	non-merging
411	172.28633	7.88348	172.28874	7.88147	15.44	15.63	-23.05	-22.80	19.80	0.36	19.08	0.0979	ph	non-merging
412	172.28682	54.11539	172.29887	54.11735	15.01	15.56	-22.37	-21.88	33.52	0.29	18.51	0.0682	sp	non-merging
413	172.29903	1.99605	172.29660	1.99748	15.60	17.11	-23.02	-21.42	19.70	0.91	19.21	0.1096	sp	merging
414	172.35637	41.87047	172.35135	41.87206	15.11	15.11	-21.81	-21.69	14.30	0.39	18.53	0.0515	ph	non-merging
415	172.43047	51.23774	172.44296	51.24576	14.06	14.27	-22.23	-21.87	30.83	0.27	16.95	0.0397	ph	non-merging
416	172.52460	44.05602	172.52341	44.04825	15.95	16.30	-22.49	-22.18	47.97	0.37	19.50	0.0943	ph	non-merging
417	172.74768	64.74887	172.73477	64.74576	16.13	17.31	-22.69	-21.44	47.62	0.14	20.88	0.1191	ph	non-merging
418	172.82791	16.72873	172.82483	16.72370	16.27	16.34	-21.74	-21.59	31.45	0.52	19.94	0.0818	ph	non-merging
419	172.99667	58.87049	173.00623	58.87387	16.92	17.05	-21.59	-21.50	41.08	0.43	20.43	0.1072	sp	non-merging
420	173.13646	58.40606	173.14578	58.40634	16.06	16.81	-22.93	-22.10	35.31	0.38	20.84	0.1135	sp	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
421	173.15800	29.83412	173.16473	29.83867	15.24	15.95	-22.60	-21.80	39.20	0.39	18.92	0.0802	sp	non-merging
422	173.24710	38.91676	173.24904	38.91594	16.22	16.62	-22.55	-22.03	12.04	0.40	20.48	0.1097	sp	non-merging
423	173.41911	29.48528	173.42386	29.49151	15.93	16.05	-21.67	-21.76	39.92	0.55	19.31	0.0809	sp	non-merging
424	173.65050	37.83028	173.65376	37.83514	16.67	17.01	-21.96	-21.52	39.68	0.24	21.05	0.1134	sp	non-merging
425	173.68990	27.95975	173.69275	27.95734	16.12	16.77	-22.26	-21.53	23.47	0.48	18.77	0.1046	sp	merging
426	173.91669	55.18280	173.92038	55.18015	14.97	15.22	-22.09	-21.95	13.26	0.27	19.30	0.0576	sp	non-merging
427	174.01465	55.07529	174.01639	55.06384	14.02	14.86	-23.16	-22.08	43.67	0.29	17.56	0.0559	sp	non-merging
428	174.03485	7.22931	174.02852	7.23124	15.39	15.85	-22.66	-22.37	38.57	0.32	19.46	0.0898	ph	non-merging
429	174.12062	25.92218	174.11771	25.92838	16.80	16.81	-21.72	-21.73	48.15	0.02	20.23	0.1123	sp	non-merging
430	174.16820	32.87737	174.16589	32.86922	14.98	15.42	-23.49	-22.82	47.16	0.87	17.11	0.0858	ph	merging
431	174.19727	14.40014	174.19431	14.40082	15.62	16.37	-22.96	-22.13	19.77	0.18	19.28	0.1044	ph	non-merging
432	174.32207	57.13076	174.32919	57.13129	15.98	16.52	-22.77	-22.10	28.73	0.06	19.81	0.1160	sp	non-merging
433	174.39560	17.80034	174.39902	17.80250	16.88	16.94	-21.39	-21.49	26.31	0.35	20.56	0.1049	sp	non-merging
434	174.59352	59.88039	174.59695	59.87962	15.73	16.29	-23.17	-22.46	13.36	0.84	18.99	0.1109	sp	merging
435	174.67216	60.17801	174.68178	60.17289	15.63	16.80	-23.33	-21.65	48.08	0.64	19.54	0.1072	ph	non-merging
436	174.98465	43.89486	174.98854	43.89028	15.49	16.58	-23.42	-21.84	35.33	0.00	20.00	0.1021	sp	non-merging
437	174.98820	-3.56404	174.98045	-3.56536	14.84	15.52	-22.55	-21.74	33.34	0.39	18.88	0.0630	sp	non-merging
438	175.12105	43.58831	175.12103	43.58955	16.49	16.54	-21.94	-21.78	8.13	0.36	19.86	0.1020	sp	non-merging
439	175.28337	10.74609	175.28711	10.74385	16.04	16.40	-23.13	-22.32	27.46	0.74	17.42	0.0986	ph	non-merging
440	175.30486	-1.96836	175.29956	-1.96232	15.78	15.99	-21.95	-21.71	42.80	0.40	19.73	0.0807	sp	non-merging
441	175.39516	8.04125	175.39793	8.04221	15.42	16.37	-23.37	-22.60	20.54	0.27	18.26	0.1104	ph	non-merging
442	175.46159	22.50768	175.46085	22.50226	16.10	16.51	-22.07	-21.85	33.23	0.15	19.46	0.0934	sp	non-merging
443	175.49797	7.13215	175.50031	7.13074	16.56	16.90	-22.05	-21.67	18.80	0.13	20.07	0.1084	ph	non-merging
444	175.50827	9.92869	175.50887	9.93354	15.38	16.19	-22.36	-21.69	24.94	0.41	18.67	0.0771	sp	non-merging
445	175.55180	31.09585	175.55304	31.09333	16.34	16.87	-22.14	-21.49	17.70	0.47	19.86	0.1003	sp	merging
446	175.71124	-2.83100	175.70587	-2.83127	16.19	17.17	-23.03	-21.73	39.64	0.00	20.95	0.1164	sp	non-merging
447	175.73239	18.90016	175.73976	18.90055	15.52	15.80	-21.74	-21.56	31.73	0.20	18.46	0.0677	ph	non-merging
448	175.73695	10.28416	175.73938	10.28493	17.04	17.12	-21.88	-21.71	18.89	0.27	21.15	0.1191	sp	non-merging
449	175.84521	28.59449	175.85143	28.59140	16.52	16.70	-22.35	-21.49	41.09	0.00	20.21	0.1017	sp	non-merging
450	175.88109	-1.75238	175.87688	-1.75671	16.53	16.89	-22.49	-21.89	40.75	0.00	21.03	0.1050	sp	non-merging
451	175.90758	41.39301	175.90184	41.39565	16.43	16.69	-22.07	-21.80	33.42	0.53	20.94	0.1029	sp	non-merging
452	175.93436	7.49512	175.93745	7.49315	16.47	16.68	-22.37	-22.30	25.77	0.34	20.03	0.1107	ph	non-merging
453	176.06671	30.90738	176.07034	30.91463	15.12	16.01	-22.43	-21.62	38.32	0.25	19.13	0.0728	sp	non-merging
454	176.11331	37.14220	176.11331	37.14453	16.29	16.75	-22.74	-22.06	17.06	0.45	20.30	0.1153	sp	non-merging
455	176.29871	17.81927	176.29616	17.82436	16.90	17.26	-21.69	-21.37	41.85	0.29	20.30	0.1173	ph	non-merging
456	176.32326	21.42065	176.32773	21.42744	14.47	15.85	-23.55	-21.92	36.35	0.66	18.75	0.0681	sp	merging
457	176.53201	8.37032	176.52884	8.37200	15.91	16.41	-22.81	-21.75	23.46	0.56	19.17	0.1022	ph	non-merging
458	176.53458	-1.11941	176.53413	-1.12078	16.72	16.86	-22.20	-22.24	10.86	1.08	21.01	0.1189	sp	non-merging
459	176.88348	11.74071	176.87814	11.73967	15.38	15.84	-22.71	-22.19	31.98	1.31	17.80	0.0920	ph	merging
460	176.91299	25.48609	176.91670	25.48095	15.63	16.42	-23.76	-22.72	40.79	0.00	20.59	0.1032	ph	non-merging
461	176.92128	7.02763	176.92287	7.02805	16.59	16.90	-22.03	-21.80	11.18	0.04	21.53	0.1070	ph	non-merging
462	176.93794	-1.95253	176.93939	-1.94708	16.74	17.18	-22.61	-21.69	41.01	0.00	30.80	0.1146	sp	non-merging
463	176.96991	25.50268	176.96489	25.49798	16.35	16.51	-22.01	-22.04	44.61	0.13	19.36	0.1065	sp	non-merging
464	176.99812	-1.11002	176.99890	-1.10587	16.13	16.17	-22.00	-21.94	26.06	0.13	18.59	0.0951	sp	non-merging
465	177.24400	10.31301	177.25000	10.31299	16.56	17.17	-23.02	-22.05	43.38	0.07	21.52	0.1159	sp	non-merging
466	177.28134	-1.36653	177.28799	-1.36244	15.78	15.80	-22.06	-21.89	41.82	0.17	19.25	0.0812	sp	non-merging
467	177.32950	9.42862	177.33224	9.42430	15.16	15.87	-22.97	-22.31	29.21	0.04	19.18	0.0873	sp	non-merging
468	177.38007	8.43815	177.38098	8.43739	16.64	17.37	-22.92	-21.23	8.89	2.12	19.73	0.1194	ph	non-merging
469	177.47209	5.70080	177.47507	5.70026	15.07	15.96	-23.13	-21.62	14.88	0.59	19.55	0.0743	sp	non-merging
470	177.54701	53.72242	177.55667	53.72126	14.70	15.60	-22.66	-21.23	23.80	0.17	17.12	0.0604	sp	non-merging
471	178.13788	8.10121	178.14267	8.10685	15.01	16.14	-22.95	-21.60	40.35	0.18	18.30	0.0831	ph	non-merging
472	178.23557	4.36046	178.23715	4.35051	15.55	15.94	-22.07	-21.47	46.91	0.42	19.29	0.0696	ph	non-merging
473	178.31624	1.21121	178.31543	1.20460	15.61	16.24	-22.20	-21.41	34.38	0.20	19.78	0.0780	sp	non-merging
474	178.52559	3.92100	178.52637	3.91759	15.32	16.16	-22.58	-21.18	17.41	0.54	19.85	0.0750	sp	merging
475	178.75723	15.46958	178.75732	15.47095	15.90	16.92	-22.88	-21.76	9.95	0.66	20.79	0.1133	sp	non-merging
476	178.78481	6.61366	178.78983	6.60909	16.20	17.08	-22.57	-22.04	48.72	0.22	20.30	0.1133	ph	non-merging
477	178.91347	12.73094	178.91835	12.73207	15.26	15.89	-22.80	-23.02	26.16	1.07	19.41	0.0810	sp	merging
478	178.95470	27.32120	178.95334	27.32527	16.16	16.41	-21.75	-21.61	24.03	0.42	20.16	0.0863	sp	non-merging
479	179.39372	56.97520	179.38789	56.97266	16.05	16.81	-23.20	-22.83	30.83	0.75	17.67	0.1200	sp	non-merging
480	179.59607	26.33227	179.59418	26.33000	16.61	16.99	-22.14	-21.82	20.33	0.14	20.26	0.1129	sp	non-merging
481	179.77905	54.80134	179.77272	54.79392	16.01	16.32	-22.12	-21.55	44.65	0.40	20.04	0.0818	sp	non-merging
482	179.92590	63.65940	179.92856	63.66016	16.07	16.69	-22.36	-21.38	8.80	0.38	20.60	0.0971	sp	non-merging
483	180.08354	56.28620	180.08781	56.28925	15.18	15.66	-23.88	-22.09	19.53	0.85	17.88	0.0761	ph	merging
484	180.15979	10.70749	180.15590	10.70962	14.43	15.30	-22.87	-21.73	18.46	0.21	18.67	0.0625	sp	non-merging
485	180.19551	46.86535	180.20320	46.86662	16.05	16.43	-22.35	-22.03	35.66	0.23	20.93	0.1023	sp	non-merging
486	180.37935	45.62515	180.38441	45.63245	14.40	15.30	-23.03	-22.53	36.78	0.55	16.65	0.0676	sp	merging
487	180.40752	3.26107	180.40385	3.25975	15.39	16.17	-22.81	-21.89	21.47	0.19	19.07	0.0840	sp	non-merging
488	180.45093	55.75385	180.44147	55.75822	16.27	16.77	-21.93	-21.69	46.10	0.31	19.23	0.1040	sp	non-merging
489	180.45305	31.10063	180.45261	31.09959	16.57	16.75	-22.15	-22.03	8.08	0.58	19.17	0.1153	ph	merging
490	180.51587	58.03553	180.52454	58.03451	15.54	16.73	-23.33	-21.79	31.47	0.18	19.08	0.1042	sp	non-merging
491	180.52713	61.59941	180.52431	61.59824	16.14	16.69	-22.13	-21.53	11.42	0.31	19.70	0.0993	sp	non-merging
492	180.92038	3.79421	180.92374	3.79983	16.28	16.98	-22.31	-21.71	47.07	0.15	20.84	0.1131	sp	non-merging
493	181.06784	28.20226	181.06450	28.20438	15.58	15.91	-22.33	-21.75	19.20	0.40	19.20	0.0801	sp	non-merging
494	181.25229	67.15715	181.25020	67.15535	16.75	17.12	-21.60	-21.50	14.05	0.62	20.73	0.1116	sp	non-merging
495	181.36050	51.33966	181.36246	51.33854	15.84	16.24	-22.66	-22.28	11.08	0.53	20.04	0.1041	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
496	181.52786	15.71790	181.52695	15.71581	17.18	17.26	-21.44	-21.92	17.08	0.13	20.26	0.1190	sp	non-merging
497	181.54312	68.63933	181.54312	68.64286	16.19	16.99	-22.33	-21.72	23.95	0.16	19.33	0.1057	sp	non-merging
498	182.03600	-2.30379	182.02994	-2.30078	16.02	16.76	-22.28	-21.41	43.33	0.13	19.78	0.0992	sp	non-merging
499	182.08301	12.28669	182.07722	12.29133	15.13	15.18	-22.07	-21.94	29.68	0.15	18.98	0.0600	sp	non-merging
500	182.41226	55.03081	182.41383	55.02693	15.42	16.94	-22.98	-21.61	27.30	0.31	18.59	0.1070	sp	non-merging
501	182.42148	0.20167	182.42503	0.20268	16.72	16.87	-21.51	-21.38	23.93	0.97	21.24	0.1003	sp	non-merging
502	182.50279	25.17237	182.50150	25.17849	16.81	16.92	-21.55	-21.38	41.59	0.48	20.05	0.1038	ph	non-merging
503	182.52541	22.13408	182.52214	22.13609	16.23	16.39	-21.70	-21.62	20.62	1.27	19.30	0.0865	ph	merging
504	183.35323	21.66894	183.34425	21.66892	15.07	15.93	-23.00	-22.86	49.86	0.22	19.02	0.0917	ph	non-merging
505	183.62161	30.14381	183.62703	30.14660	15.70	16.91	-22.86	-21.50	37.33	0.73	20.20	0.1068	sp	non-merging
506	183.70264	59.90620	183.71542	59.90839	14.14	15.29	-23.10	-21.96	27.54	0.22	17.20	0.0601	sp	non-merging
507	183.82980	44.15445	183.82745	44.14996	16.50	16.99	-22.00	-21.51	34.38	0.52	19.60	0.1127	sp	merging
508	184.22359	58.60873	184.21149	58.60815	16.64	16.81	-22.01	-21.82	46.28	0.46	21.73	0.1152	sp	non-merging
509	184.22826	23.62701	184.22366	23.62432	16.05	16.65	-22.35	-21.62	34.09	0.61	19.90	0.1064	ph	non-merging
510	184.48627	8.15642	184.49023	8.16621	15.73	15.73	-22.00	-21.92	47.74	1.01	19.45	0.0675	ph	non-merging
511	184.71233	10.66705	184.71346	10.67360	16.06	16.53	-22.32	-21.85	42.21	1.06	20.69	0.0981	sp	non-merging
512	184.72696	20.80960	184.73024	20.81271	15.69	15.72	-22.37	-22.70	20.98	0.00	20.05	0.0720	ph	non-merging
513	184.88379	62.15546	184.86955	62.15792	15.98	16.69	-22.41	-21.49	47.68	0.30	19.89	0.1047	sp	non-merging
514	185.07866	29.99609	185.08237	29.99313	16.65	17.16	-22.00	-21.72	31.76	0.30	20.28	0.1145	sp	non-merging
515	185.10205	61.09994	185.11441	61.10253	15.33	15.77	-22.68	-21.82	30.34	0.00	19.28	0.0697	sp	non-merging
516	185.10304	9.47874	185.10324	9.48559	15.81	16.39	-22.09	-21.58	42.24	0.12	19.15	0.0949	sp	non-merging
517	185.43239	13.75457	185.42358	13.75297	15.32	16.13	-22.57	-21.58	46.91	0.49	20.23	0.0817	sp	non-merging
518	185.44576	7.80654	185.44191	7.80899	15.94	17.32	-22.85	-21.65	34.14	0.45	20.86	0.1194	ph	non-merging
519	185.55367	22.92026	185.55484	22.91355	15.93	16.17	-21.86	-22.01	35.54	0.72	19.75	0.0791	ph	merging
520	185.58861	13.78699	185.59286	13.78922	16.75	16.92	-21.87	-21.62	35.23	0.34	20.59	0.1186	ph	non-merging
521	185.71381	19.15909	185.71594	19.16442	16.35	16.49	-21.97	-22.01	41.78	0.68	20.21	0.1155	ph	non-merging
522	185.85860	21.91958	185.85457	21.92537	16.26	16.68	-22.33	-22.34	48.78	0.44	20.28	0.1110	ph	non-merging
523	186.06273	27.42326	186.05977	27.42346	15.46	16.23	-23.08	-22.04	15.88	0.41	19.37	0.0925	sp	non-merging
524	186.06503	20.28954	186.06087	20.28588	14.59	15.12	-22.60	-21.74	19.75	0.29	17.82	0.0542	ph	non-merging
525	186.11491	27.23544	186.11314	27.23698	15.86	17.14	-23.45	-21.11	15.89	1.12	17.67	0.1132	sp	merging
526	186.17519	4.27101	186.17528	4.27330	15.53	16.13	-22.27	-21.41	11.77	1.18	19.45	0.0775	ph	non-merging
527	186.37276	4.13887	186.37051	4.14092	16.21	16.26	-22.43	-22.37	21.39	0.36	20.01	0.1107	ph	non-merging
528	186.37457	23.58163	186.38121	23.59105	15.59	14.68	-21.36	-22.59	44.82	0.48	18.34	0.0590	ph	non-merging
529	186.39029	46.06715	186.40263	46.06410	14.44	14.81	-22.19	-21.58	29.54	0.34	16.73	0.0473	sp	non-merging
530	186.52701	40.92893	186.52826	40.92368	16.04	16.31	-22.35	-22.22	33.45	0.82	18.92	0.0968	sp	merging
531	186.67432	26.08030	186.67523	26.08420	16.30	16.73	-22.32	-21.71	27.99	0.50	19.31	0.1098	ph	merging
532	186.67636	43.78447	186.67496	43.78232	15.81	16.27	-22.91	-22.23	16.98	1.16	19.18	0.1119	sp	merging
533	186.87810	8.82456	186.87500	8.82489	14.66	15.32	-23.75	-22.99	18.35	0.53	17.27	0.0914	ph	merging
534	186.88454	49.47889	186.87984	49.47768	15.70	17.08	-23.79	-21.78	24.78	1.17	20.13	0.1194	sp	non-merging
535	186.90436	-0.38404	186.90300	-0.38634	15.43	16.80	-23.37	-21.81	19.53	0.69	18.74	0.1155	sp	merging
536	186.91571	8.99494	186.91927	8.99490	16.40	17.06	-22.30	-22.33	24.99	0.00	21.10	0.1116	sp	non-merging
537	186.95535	8.77697	186.95297	8.78082	15.80	16.06	-22.38	-22.01	25.75	0.47	20.07	0.0870	sp	non-merging
538	187.28598	8.69092	187.28543	8.68807	15.57	16.22	-22.22	-21.82	15.81	0.61	19.87	0.0825	ph	non-merging
539	187.46805	11.67745	187.46373	11.67789	14.29	15.09	-23.59	-22.29	23.19	0.56	18.11	0.0828	sp	merging
540	187.48703	5.04776	187.48631	5.05100	15.23	15.50	-22.64	-22.01	15.43	0.26	19.21	0.0694	sp	non-merging
541	187.54803	11.74385	187.55067	11.74480	14.77	15.21	-22.66	-21.72	11.04	1.34	18.84	0.0592	ph	merging
542	187.70926	8.03509	187.70454	8.03916	16.41	16.59	-21.97	-21.64	38.99	0.29	19.86	0.0971	ph	non-merging
543	187.73282	38.60046	187.73218	38.59946	16.01	16.98	-22.99	-21.58	7.66	1.07	18.73	0.1068	ph	merging
544	187.82623	36.65858	187.82722	36.66453	16.96	17.18	-21.72	-21.69	45.04	0.25	21.17	0.1186	sp	non-merging
545	187.87054	49.26027	187.87222	49.25887	16.14	16.23	-22.58	-22.43	12.57	0.54	20.67	0.1113	sp	non-merging
546	187.96484	56.67120	187.96333	56.67228	17.01	17.07	-21.74	-21.58	9.90	0.10	20.71	0.1142	sp	non-merging
547	188.03300	11.55264	188.03908	11.55210	15.60	15.87	-22.32	-22.02	33.90	0.13	18.51	0.0865	sp	non-merging
548	188.03763	64.10401	188.02490	64.11111	15.76	16.14	-21.94	-21.49	47.02	0.55	20.37	0.0788	sp	non-merging
549	188.22144	64.14748	188.22104	64.14562	15.29	16.13	-22.97	-21.26	9.72	0.00	21.27	0.0789	sp	non-merging
550	188.23816	9.29893	188.23911	9.29939	15.74	16.45	-23.13	-21.71	7.01	2.32	19.61	0.1048	sp	merging
551	188.25871	-1.54052	188.26662	-1.53783	15.65	15.89	-22.39	-22.15	47.15	0.17	18.05	0.0861	ph	non-merging
552	188.30020	67.11430	188.31314	67.11827	16.62	16.73	-22.13	-22.00	42.52	0.06	19.69	0.1030	sp	non-merging
553	188.30862	67.12878	188.31342	67.12870	15.05	16.06	-23.99	-22.10	12.93	0.07	18.68	0.1084	sp	non-merging
554	188.38899	6.86427	188.38545	6.86608	15.94	16.95	-23.18	-22.21	29.78	0.39	18.87	0.1193	ph	non-merging
555	188.64493	61.69343	188.64380	61.69641	16.77	17.15	-22.40	-22.08	22.07	0.02	19.79	0.1150	sp	non-merging
556	188.71599	58.91679	188.72791	58.91262	13.67	14.79	-22.84	-21.62	21.94	0.16	16.77	0.0427	sp	non-merging
557	188.78793	-3.59709	188.78636	-3.58853	14.76	15.38	-22.70	-21.89	35.11	0.34	18.63	0.0596	sp	non-merging
558	188.82983	27.57805	188.83531	27.58086	16.04	16.28	-22.45	-22.26	35.34	1.39	19.11	0.0972	sp	merging
559	188.99019	11.27218	188.98801	11.27442	15.42	15.88	-22.88	-22.31	19.40	0.37	18.99	0.0966	sp	non-merging
560	189.03546	16.64743	189.03304	16.64776	16.19	16.51	-23.26	-23.01	14.85	0.00	20.32	0.0977	ph	non-merging
561	189.10742	16.53841	189.11479	16.53869	15.09	15.40	-22.50	-23.44	34.09	1.88	18.66	0.0723	ph	merging
562	189.33789	57.25619	189.34322	57.25673	15.89	16.15	-22.71	-22.54	19.65	2.53	18.76	0.1043	sp	merging
563	189.80273	9.31985	189.80124	9.32632	15.77	16.34	-22.31	-21.72	36.38	0.82	20.83	0.0831	sp	non-merging
564	189.88553	-0.39374	189.88287	-0.38608	15.99	16.00	-21.65	-21.80	39.06	0.17	19.41	0.0722	sp	non-merging
565	189.90305	53.56131	189.89595	53.56036	16.41	16.65	-23.23	-22.00	30.39	0.78	18.43	0.1102	sp	merging
566	189.96402	16.41588	189.96672	16.42225	15.42	15.56	-22.46	-21.76	31.64	0.21	18.21	0.0687	ph	non-merging
567	189.97626	61.21161	189.97806	61.21274	16.02	16.63	-22.60	-21.52	9.54	0.51	20.47	0.1042	sp	non-merging
568	190.03537	18.05502	190.03416	18.05545	16.19	16.89	-22.17	-21.31	8.00	1.40	20.16	0.1010	ph	non-merging
569	190.30191	3.38418	190.30331	3.37999	16.01	17.08	-22.81	-21.79	33.11	0.47	20.45	0.1186	ph	non-merging
570	190.54933	20.88485	190.55243	20.88048	15.31	15.63	-23.02	-22.47	31.18	0.68	19.85	0.0911	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
571	190.92300	19.32703	190.92299	19.32315	16.03	16.24	-22.19	-21.86	24.66	0.45	19.73	0.0982	ph	non-merging
572	190.92880	-1.94377	190.93225	-1.95029	15.14	16.45	-22.90	-21.48	41.80	0.28	18.85	0.0864	sp	non-merging
573	190.93552	30.24098	190.94261	30.24046	16.25	16.38	-22.19	-22.05	38.71	0.09	19.22	0.0971	sp	non-merging
574	190.94135	6.50409	190.93753	6.50241	15.32	15.33	-22.18	-22.11	19.74	0.29	19.01	0.0714	sp	non-merging
575	190.94453	39.52974	190.94589	39.52898	16.27	16.47	-22.49	-21.91	8.97	0.00	20.73	0.1082	sp	non-merging
576	191.27382	16.32139	191.28062	16.32602	15.65	15.93	-21.98	-22.08	40.03	0.56	19.40	0.0752	ph	non-merging
577	191.49208	7.35310	191.48270	7.34780	15.57	15.66	-21.94	-21.72	49.31	0.20	18.67	0.0687	sp	non-merging
578	192.01117	-1.65284	192.01495	-1.64737	15.18	15.23	-22.91	-22.75	38.32	0.15	18.91	0.0880	sp	non-merging
579	192.03532	64.03692	192.04483	64.03732	15.85	17.00	-23.30	-22.10	29.65	0.53	19.29	0.1112	sp	merging
580	192.05057	63.04062	192.05530	63.04626	16.50	16.57	-21.84	-21.87	40.14	0.25	20.18	0.1034	sp	non-merging
581	192.28415	-1.79024	192.28151	-1.78488	15.56	16.28	-22.72	-21.86	34.37	0.34	19.75	0.0879	sp	non-merging
582	192.47673	12.91045	192.47858	12.91409	15.88	16.30	-22.18	-21.70	22.80	0.56	19.70	0.0855	sp	merging
583	192.49419	-3.57595	192.50014	-3.57571	15.15	15.40	-21.89	-21.80	24.82	0.11	18.16	0.0619	ph	non-merging
584	192.64781	50.38526	192.64445	50.38003	16.87	16.93	-21.58	-21.46	39.05	0.26	20.64	0.1079	sp	non-merging
585	192.79550	17.08370	192.80086	17.07657	16.42	16.44	-21.61	-21.73	49.76	0.46	20.80	0.0864	ph	non-merging
586	192.94490	66.69983	192.94814	66.70086	16.30	16.33	-22.22	-22.14	8.94	0.00	30.73	0.0826	sp	non-merging
587	193.16913	21.41464	193.16728	21.41673	15.17	16.14	-23.53	-22.31	17.29	1.42	19.13	0.0988	ph	merging
588	193.21716	46.75819	193.20880	46.75758	14.98	15.27	-22.14	-21.68	23.62	0.30	18.33	0.0606	sp	non-merging
589	193.27379	31.37391	193.28326	31.37373	15.36	15.63	-22.00	-21.74	36.13	0.76	19.81	0.0665	sp	merging
590	193.30287	40.84838	193.31058	40.84818	15.43	15.48	-21.84	-21.87	25.80	0.10	18.16	0.0658	sp	non-merging
591	193.49597	39.61399	193.49873	39.61368	16.26	16.55	-22.45	-22.07	15.41	0.51	18.74	0.1126	sp	merging
592	193.70702	-2.62337	193.70755	-2.62525	16.81	17.25	-22.10	-21.48	14.76	0.00	21.31	0.1196	sp	non-merging
593	193.81909	3.29525	193.82564	3.29825	15.46	16.32	-22.25	-21.64	38.09	0.15	20.17	0.0802	sp	non-merging
594	193.82771	65.30662	193.81464	65.30204	16.13	16.45	-22.11	-22.05	40.91	0.59	19.97	0.0876	ph	non-merging
595	194.08719	62.12886	194.08620	62.13103	16.53	16.69	-22.02	-21.80	15.07	0.45	21.32	0.1062	sp	non-merging
596	194.25821	3.10011	194.26018	3.09884	16.34	16.66	-22.29	-21.74	16.27	0.61	19.78	0.1088	sp	merging
597	194.28383	6.23799	194.28409	6.23564	16.38	16.63	-21.97	-22.06	16.79	0.34	20.52	0.1114	ph	non-merging
598	194.35782	19.51782	194.36371	19.51777	16.67	17.00	-21.90	-21.72	39.91	0.53	19.27	0.1129	ph	merging
599	194.68613	50.47301	194.68877	50.47063	16.15	16.86	-22.22	-21.43	19.23	0.50	19.59	0.1025	ph	merging
600	194.91386	38.81559	194.92819	38.81131	14.00	14.36	-22.05	-21.61	29.00	0.60	18.66	0.0348	sp	non-merging
601	195.06297	24.37864	195.05937	24.38238	15.46	16.31	-22.79	-21.68	27.59	0.10	18.85	0.0844	ph	non-merging
602	195.23911	39.58312	195.24210	39.58394	14.95	15.76	-22.81	-21.70	11.71	0.45	18.93	0.0716	sp	merging
603	195.64438	0.34857	195.63524	0.34516	14.13	15.39	-23.39	-21.92	44.36	0.23	17.58	0.0678	sp	non-merging
604	195.71906	-2.51635	195.72035	-2.52055	14.36	16.16	-23.71	-21.72	23.73	0.92	17.63	0.0819	sp	merging
605	195.83221	-3.10457	195.83038	-3.11080	15.63	16.08	-23.17	-23.03	46.74	0.08	19.22	0.1132	sp	non-merging
606	195.96466	-3.45447	195.97342	-3.45555	14.53	15.53	-23.15	-21.71	39.50	0.01	17.99	0.0668	ph	non-merging
607	196.03665	18.37990	196.03500	18.37988	16.09	16.32	-22.12	-21.76	9.52	0.23	18.81	0.0935	ph	non-merging
608	196.18488	51.18864	196.18962	51.18642	15.34	16.08	-23.76	-22.55	24.06	0.94	18.67	0.1006	sp	merging
609	196.19957	51.52805	196.19260	51.53002	16.58	16.83	-21.77	-21.52	31.09	0.14	19.17	0.1011	sp	non-merging
610	196.24101	43.55343	196.26062	43.55347	14.33	14.34	-22.58	-22.04	40.51	0.00	18.95	0.0412	ph	non-merging
611	196.39581	21.13418	196.39531	21.13582	14.97	16.00	-22.67	-22.03	8.33	0.42	19.17	0.0735	ph	non-merging
612	196.50095	17.94394	196.50702	17.94767	16.54	16.69	-21.66	-21.45	41.87	0.24	19.81	0.0935	ph	non-merging
613	196.51358	6.61164	196.51526	6.61384	15.22	16.59	-23.16	-21.76	16.04	0.88	18.68	0.0888	ph	merging
614	196.63409	39.84950	196.62871	39.84441	16.23	16.73	-22.06	-21.50	45.57	0.17	19.03	0.1087	sp	non-merging
615	196.66571	18.59535	196.66951	18.59975	15.05	15.30	-22.27	-21.96	24.77	0.25	18.91	0.0648	ph	non-merging
616	196.71648	9.63943	196.71503	9.64135	14.51	14.98	-22.50	-21.75	8.73	0.30	18.57	0.0534	sp	non-merging
617	196.75061	21.59131	196.75150	21.58384	15.27	15.95	-22.41	-21.84	39.04	0.40	18.29	0.0784	ph	non-merging
618	196.76367	9.61469	196.75642	9.61793	14.78	14.85	-22.16	-22.16	29.80	0.26	19.13	0.0558	sp	non-merging
619	196.88504	9.03257	196.88612	9.03521	15.46	16.68	-22.77	-21.67	17.16	0.35	18.39	0.0926	sp	non-merging
620	196.88947	7.67492	196.89227	7.67341	16.57	16.62	-21.60	-21.71	19.78	0.20	20.30	0.0962	ph	non-merging
621	197.25522	7.97144	197.26140	7.97266	15.21	16.14	-23.03	-22.41	42.27	0.42	18.35	0.1056	ph	non-merging
622	197.26862	10.49314	197.26906	10.49868	15.11	16.54	-23.35	-21.57	31.56	0.32	18.95	0.0866	sp	non-merging
623	197.30748	34.69360	197.31166	34.69880	16.53	16.82	-22.08	-21.80	40.68	0.77	20.42	0.1012	sp	non-merging
624	197.47256	39.48590	197.47125	39.47933	16.18	16.74	-22.44	-21.91	46.37	0.36	20.57	0.1092	sp	non-merging
625	197.77014	-0.04581	197.76741	-0.03912	15.89	16.52	-22.57	-21.64	45.16	0.42	19.39	0.0964	sp	non-merging
626	197.84991	39.27840	197.85536	39.27517	15.39	15.64	-22.18	-22.00	25.46	0.32	18.62	0.0718	sp	non-merging
627	197.92023	19.50119	197.92387	19.50439	15.70	16.30	-22.59	-21.72	26.87	0.23	17.89	0.0872	ph	non-merging
628	198.30713	3.87908	198.30411	3.87948	16.21	16.46	-22.51	-22.18	20.47	1.23	18.71	0.1048	sp	merging
629	198.34776	5.98581	198.34920	5.98354	15.72	16.01	-22.02	-21.50	12.95	0.31	19.38	0.0724	sp	non-merging
630	198.41959	57.26122	198.42374	57.26939	15.43	16.20	-22.34	-21.47	43.27	0.64	19.53	0.0770	sp	merging
631	198.47675	6.91957	198.47893	6.92110	16.11	16.27	-22.39	-22.46	17.52	0.29	20.19	0.1024	ph	non-merging
632	198.71519	38.69588	198.71544	38.69451	15.69	16.05	-22.95	-22.58	9.52	0.73	18.32	0.1075	sp	merging
633	198.76750	60.89292	198.76089	60.89543	16.61	16.77	-21.99	-21.80	28.10	0.96	20.57	0.1076	sp	non-merging
634	198.99406	21.41343	198.99380	21.42116	16.13	16.52	-22.06	-22.96	45.07	0.30	19.96	0.0891	ph	non-merging
635	199.00447	43.46009	198.99805	43.46472	15.96	16.15	-22.27	-21.86	37.52	0.29	19.52	0.0870	sp	non-merging
636	199.17155	67.68843	199.16762	67.68790	14.95	15.82	-22.39	-21.68	7.07	0.81	18.70	0.0665	sp	merging
637	199.48706	22.75727	199.48595	22.75557	15.03	15.68	-22.81	-22.17	10.70	0.54	18.39	0.0815	ph	merging
638	199.49474	29.83907	199.50215	29.83657	16.67	17.10	-21.99	-21.54	48.62	0.50	20.23	0.1104	sp	non-merging
639	199.62985	11.14231	199.62631	11.14457	15.73	16.39	-22.81	-21.81	24.53	0.53	20.08	0.0907	sp	non-merging
640	199.64549	17.80224	199.64398	17.80619	16.27	17.15	-22.58	-21.53	31.52	0.38	21.00	0.1187	ph	non-merging
641	199.77803	23.32604	199.77824	23.33248	16.11	16.42	-22.46	-22.13	45.53	0.67	20.10	0.1108	ph	non-merging
642	199.81909	-0.91706	199.82013	-0.92010	14.89	15.10	-23.19	-22.65	17.34	0.43	18.97	0.0819	sp	non-merging
643	199.96146	7.02219	199.95540	7.02135	16.11	16.34	-22.05	-21.80	35.45	0.38	19.52	0.0893	ph	non-merging
644	199.99475	42.68334	199.99037	42.68649	14.39	14.92	-23.27	-22.58	22.32	3.12	17.50	0.0746	sp	merging
645	200.04706	44.55178	200.04498	44.55073	16.82	16.92	-21.79	-21.92	13.77	0.45	19.74	0.1199	sp	merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
646	200.13200	66.98160	200.13197	66.97495	15.95	16.49	-22.36	-21.95	42.62	0.68	20.49	0.0991	sp	non-merging
647	200.28217	10.77094	200.28534	10.76824	16.05	16.65	-22.61	-22.07	28.39	0.64	18.39	0.1075	sp	merging
648	200.35602	-0.69341	200.35953	-0.68757	15.40	15.92	-23.43	-23.36	46.96	0.57	18.40	0.1076	sp	merging
649	200.44191	22.13652	200.43890	22.13700	16.09	16.54	-22.17	-21.80	17.73	0.32	20.99	0.0968	ph	non-merging
650	200.44339	-1.16049	200.43842	-1.15779	16.59	16.99	-21.96	-21.68	39.41	0.60	20.43	0.1088	sp	non-merging
651	200.70105	22.34329	200.69919	22.34406	15.74	16.85	-23.03	-21.53	12.22	0.61	18.83	0.1006	ph	non-merging
652	200.97003	1.19604	200.97655	1.19299	16.93	16.95	-21.57	-21.65	49.63	0.39	21.58	0.1078	sp	non-merging
653	201.06300	-3.41662	201.06310	-3.41295	15.69	15.95	-21.99	-21.95	19.12	1.13	18.12	0.0787	sp	merging
654	201.07388	47.38424	201.07341	47.39192	15.71	16.62	-22.42	-21.53	45.78	0.64	20.26	0.0913	sp	non-merging
655	201.25098	1.78272	201.25069	1.78147	16.79	17.15	-21.89	-21.51	9.01	0.50	19.95	0.1103	sp	merging
656	201.31706	40.51352	201.31660	40.52039	14.95	15.73	-23.32	-21.37	29.16	0.25	19.18	0.0628	sp	non-merging
657	201.42268	-1.36456	201.42474	-1.35989	15.35	16.18	-22.04	-21.50	25.60	0.80	19.25	0.0755	ph	non-merging
658	201.76208	17.49440	201.76892	17.49164	15.42	16.08	-23.29	-22.59	43.87	1.15	18.51	0.0954	ph	merging
659	202.06097	-1.44775	202.06465	-1.44594	16.19	16.52	-21.92	-21.38	23.24	0.30	20.26	0.0864	sp	non-merging
660	202.07214	0.28874	202.07401	0.28894	15.75	16.13	-22.65	-23.33	13.20	1.04	19.51	0.1105	sp	merging
661	202.18329	19.34878	202.18997	19.34833	14.73	16.47	-23.60	-21.67	36.40	0.32	18.87	0.0879	ph	non-merging
662	202.19139	-2.25341	202.18781	-2.24902	15.20	15.79	-22.99	-22.15	32.03	0.40	19.15	0.0862	sp	non-merging
663	202.23927	54.31422	202.23805	54.31986	16.51	16.66	-22.25	-21.81	38.03	0.09	20.10	0.1041	sp	non-merging
664	202.27789	54.53360	202.27798	54.53866	16.78	16.83	-21.53	-21.63	33.31	0.30	20.52	0.1021	sp	non-merging
665	202.54303	-2.10501	202.54556	-2.10378	15.42	15.44	-22.59	-23.24	15.95	0.75	17.98	0.0864	sp	merging
666	202.75598	53.10099	202.75514	53.10693	16.07	16.42	-22.51	-22.31	38.83	0.40	19.92	0.1009	sp	non-merging
667	202.79596	-1.72729	202.79512	-1.73026	14.61	14.81	-23.38	-23.74	17.00	0.62	18.39	0.0836	sp	merging
668	202.79947	20.88966	202.80112	20.89083	16.71	17.01	-22.41	-22.09	14.60	0.64	19.29	0.1197	ph	merging
669	202.83618	54.09295	202.83791	54.09356	16.54	16.65	-21.81	-21.93	7.97	0.69	21.29	0.1054	sp	non-merging
670	203.05589	12.58819	203.05586	12.58105	15.31	15.96	-22.46	-21.72	34.92	0.21	19.76	0.0735	sp	non-merging
671	203.06554	-1.88531	203.05920	-1.88587	15.50	16.27	-22.64	-21.86	35.35	0.24	18.14	0.0846	sp	non-merging
672	203.11467	24.01127	203.11639	24.01697	15.09	15.26	-22.30	-21.96	25.49	0.31	19.11	0.0640	ph	non-merging
673	203.17125	11.70033	203.16339	11.70258	15.73	16.22	-22.17	-22.64	46.85	0.48	19.31	0.0894	sp	non-merging
674	203.19398	18.81311	203.19353	18.82236	15.98	16.39	-21.82	-21.31	49.76	0.18	19.57	0.0815	ph	non-merging
675	203.34943	53.34267	203.34274	53.34739	15.63	16.75	-22.84	-21.62	40.21	0.20	18.01	0.1009	sp	non-merging
676	203.46399	9.94790	203.46303	9.94181	14.96	15.71	-22.97	-22.56	29.70	0.40	19.33	0.0723	sp	non-merging
677	203.93716	5.51910	203.93100	5.51850	16.08	16.34	-21.70	-21.68	33.68	0.75	19.27	0.0829	sp	merging
678	203.94130	47.42015	203.94537	47.41787	14.43	15.20	-23.29	-21.75	15.03	0.36	18.65	0.0622	sp	non-merging
679	203.96802	54.86572	203.96053	54.86113	16.45	17.05	-22.06	-21.55	43.81	0.25	21.33	0.1088	sp	non-merging
680	204.02220	59.19399	204.03424	59.19329	15.50	15.51	-22.24	-22.80	30.68	0.00	20.12	0.0743	sp	non-merging
681	204.18451	-3.49791	204.18343	-3.50086	14.91	15.71	-22.94	-22.02	14.40	1.02	17.78	0.0683	ph	merging
682	204.19431	43.84138	204.19228	43.84393	15.05	15.23	-22.31	-22.29	12.45	0.59	16.87	0.0630	sp	merging
683	204.61909	31.63016	204.61717	31.62758	16.59	17.11	-22.12	-21.64	21.32	0.41	20.24	0.1092	ph	non-merging
684	204.66000	63.32910	204.64839	63.33294	16.18	16.95	-22.94	-21.34	43.65	0.00	20.50	0.1049	sp	non-merging
685	204.85277	30.99080	204.84639	30.99235	13.73	15.21	-23.93	-22.11	23.76	0.65	17.24	0.0620	ph	merging
686	204.90471	9.94056	204.90381	9.94347	16.15	16.22	-22.14	-21.85	17.69	0.38	19.28	0.0890	ph	non-merging
687	204.99867	29.87904	205.00414	29.88229	16.42	16.72	-22.93	-22.13	41.99	0.46	19.74	0.1151	sp	merging
688	205.05247	3.94481	205.05260	3.93809	16.92	17.05	-21.83	-21.61	49.66	0.55	21.38	0.1165	sp	non-merging
689	205.28389	28.88632	205.29004	28.88858	16.82	16.97	-21.50	-21.53	39.28	0.22	19.79	0.1048	sp	non-merging
690	205.38069	10.30033	205.37555	10.30153	16.27	16.60	-21.93	-21.51	32.60	0.16	20.07	0.0967	sp	non-merging
691	205.42314	11.52314	205.42123	11.53040	15.90	16.52	-22.27	-21.82	45.80	0.39	19.27	0.0939	sp	non-merging
692	205.45477	26.37347	205.46115	26.36903	13.83	15.20	-23.73	-22.35	34.69	0.30	17.39	0.0718	ph	non-merging
693	205.54018	2.22721	205.54887	2.22449	14.70	15.95	-23.55	-21.63	45.87	0.32	19.08	0.0758	sp	non-merging
694	206.09932	7.88708	206.09796	7.88616	16.30	16.53	-22.25	-22.09	10.12	0.61	18.60	0.0957	ph	merging
695	206.13020	55.62738	206.12054	55.63021	15.42	15.73	-21.96	-22.49	28.51	1.05	17.80	0.0694	sp	merging
696	206.37296	5.83138	206.36839	5.82696	16.41	16.89	-22.38	-21.74	46.33	0.30	21.05	0.1153	ph	non-merging
697	206.48776	6.11657	206.49420	6.11699	16.40	16.91	-21.88	-21.61	41.78	0.30	20.60	0.1009	ph	non-merging
698	206.50194	9.30459	206.49818	9.29971	16.97	17.20	-21.80	-21.46	45.75	0.19	19.70	0.1181	sp	non-merging
699	206.64665	17.60645	206.64330	17.60447	15.17	15.47	-22.69	-22.34	19.38	0.34	18.83	0.0777	ph	non-merging
700	206.96925	21.25202	206.96823	21.25315	16.06	16.86	-22.64	-21.42	10.08	0.32	20.14	0.1061	ph	non-merging
701	207.20999	54.25753	207.21567	54.25453	16.01	16.47	-22.39	-21.93	29.18	0.22	19.10	0.1013	sp	non-merging
702	207.21143	23.22817	207.21420	23.23220	16.54	16.97	-22.02	-21.60	33.94	0.37	20.16	0.1115	ph	non-merging
703	207.26892	16.55988	207.26726	16.55910	15.91	16.80	-23.16	-21.29	11.80	1.03	18.07	0.1034	ph	non-merging
704	207.99355	10.07196	207.99141	10.07358	15.72	16.38	-22.19	-21.57	15.09	0.17	18.79	0.0866	ph	non-merging
705	208.00900	66.83895	208.00404	66.83868	14.99	15.72	-22.72	-21.56	8.94	0.55	18.55	0.0677	sp	merging
706	208.10207	37.51770	208.09805	37.52498	15.71	15.80	-22.26	-22.00	42.43	0.14	18.62	0.0809	ph	non-merging
707	208.39468	36.54077	208.39384	36.54276	16.13	16.98	-22.19	-21.62	14.17	0.21	18.73	0.1051	sp	non-merging
708	208.39789	16.89285	208.39539	16.89161	15.96	16.44	-22.45	-22.99	16.89	0.00	20.50	0.0967	ph	non-merging
709	208.43251	33.22215	208.42397	33.22808	13.93	14.48	-22.51	-22.28	25.50	0.53	17.27	0.0396	ph	merging
710	208.53491	12.02155	208.52744	12.02660	15.11	15.28	-22.27	-22.69	39.24	0.19	18.41	0.0657	sp	non-merging
711	208.54854	43.02344	208.54697	43.02415	16.04	16.36	-23.08	-22.87	9.91	1.12	18.68	0.1158	sp	merging
712	208.66899	20.71701	208.66742	20.72021	14.78	15.26	-22.13	-21.59	12.87	0.31	18.53	0.0535	ph	non-merging
713	208.89099	35.34939	208.89275	35.35464	16.18	16.66	-21.97	-21.62	35.68	1.26	19.81	0.1016	sp	non-merging
714	208.92967	28.02018	208.92598	28.01851	15.94	16.01	-21.68	-21.53	18.12	0.17	19.76	0.0743	sp	non-merging
715	209.02286	19.77958	209.01993	19.77617	14.38	15.99	-23.82	-22.20	25.15	0.67	17.75	0.0874	ph	merging
716	209.12103	22.69903	209.12151	22.69637	15.25	15.62	-22.59	-22.30	14.17	0.20	19.52	0.0797	ph	non-merging
717	209.15883	31.30208	209.16168	31.29692	16.80	17.25	-21.81	-21.22	42.89	0.31	21.47	0.1189	ph	non-merging
718	209.49200	7.54952	209.48990	7.54733	17.05	17.12	-21.71	-21.45	22.18	0.26	20.95	0.1154	sp	non-merging
719	209.51361	20.61903	209.51443	20.62764	14.47	15.25	-22.67	-22.24	34.43	0.18	18.15	0.0588	ph	non-merging
720	209.51808	5.96265	209.51514	5.95470	15.94	16.09	-21.70	-21.46	41.74	0.46	18.86	0.0740	ph	merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
721	209.61229	8.11417	209.61086	8.11741	15.45	17.06	-23.68	-21.57	24.85	0.62	20.65	0.1101	ph	non-merging
722	209.62929	35.33834	209.63017	35.34268	16.56	16.65	-21.62	-21.63	28.25	0.56	19.95	0.0993	sp	non-merging
723	209.63197	49.53981	209.63161	49.53710	15.49	16.99	-23.74	-21.84	18.36	0.98	18.36	0.1052	sp	merging
724	209.73958	22.26040	209.74591	22.25776	15.77	16.47	-22.83	-22.14	45.94	0.28	19.27	0.1122	ph	non-merging
725	209.81772	5.22145	209.81573	5.21631	15.95	16.39	-22.66	-22.39	39.53	0.85	20.15	0.1127	sp	non-merging
726	209.96184	4.67128	209.95949	4.66883	16.53	16.67	-22.42	-22.07	24.35	0.02	20.70	0.1130	ph	non-merging
727	210.00356	28.49995	209.99091	28.50297	14.71	15.67	-22.74	-21.68	48.53	0.47	17.83	0.0624	sp	merging
728	210.08113	63.94073	210.08907	63.93800	16.53	16.82	-22.23	-21.77	30.74	1.42	21.19	0.1086	sp	non-merging
729	210.23639	55.93418	210.23224	55.93262	16.12	16.84	-22.36	-21.66	19.19	0.46	20.13	0.1069	sp	non-merging
730	210.38164	56.43174	210.39537	56.43460	15.42	15.69	-22.30	-21.90	39.39	0.30	18.50	0.0728	sp	non-merging
731	210.61327	27.28644	210.60919	27.29043	16.23	16.79	-22.63	-22.02	39.54	0.45	19.73	0.1158	sp	merging
732	210.63785	10.53218	210.63255	10.53281	16.86	16.97	-22.03	-21.63	38.11	0.37	20.34	0.1144	ph	non-merging
733	210.85388	6.94349	210.85280	6.94442	16.36	16.50	-22.38	-23.20	10.19	0.85	19.39	0.1130	sp	merging
734	210.97234	15.33086	210.97693	15.32800	15.79	16.57	-22.83	-21.97	35.55	0.86	19.84	0.1051	ph	merging
735	210.99400	14.86458	210.99525	14.86633	16.55	17.04	-22.08	-21.37	15.43	0.93	19.80	0.1143	ph	merging
736	211.03885	40.56187	211.03220	40.56039	17.00	17.02	-21.69	-21.54	36.82	0.19	19.83	0.1094	sp	non-merging
737	211.59589	29.40629	211.59688	29.40369	15.65	16.48	-22.91	-22.17	16.64	1.78	17.89	0.0935	ph	merging
738	211.66054	18.73474	211.65942	18.73770	15.91	15.97	-22.27	-22.17	18.99	0.39	18.59	0.0928	ph	non-merging
739	211.71080	18.95558	211.70457	18.96518	14.77	15.17	-22.30	-21.77	40.99	0.52	18.75	0.0534	ph	non-merging
740	212.00119	55.73209	212.00325	55.72937	16.07	16.25	-22.00	-21.83	17.09	0.30	18.41	0.0885	sp	non-merging
741	212.02634	42.69925	212.02760	42.70023	16.66	16.89	-22.67	-22.28	9.64	0.83	19.33	0.1116	sp	merging
742	212.09601	23.36130	212.09343	23.36160	15.29	15.59	-22.61	-22.58	12.31	0.26	19.34	0.0778	ph	non-merging
743	212.39224	10.62691	212.39854	10.62669	16.18	16.36	-22.10	-21.88	39.01	0.16	19.66	0.0971	sp	non-merging
744	212.41350	-0.88893	212.41388	-0.88535	15.98	16.66	-23.14	-22.22	26.19	1.25	18.26	0.1147	sp	merging
745	212.42490	34.19860	212.41785	34.19851	15.85	16.35	-22.32	-21.94	39.04	0.22	18.30	0.1041	sp	non-merging
746	212.49785	-1.53965	212.49765	-1.53858	15.87	16.81	-23.17	-22.71	8.13	3.49	19.09	0.1170	sp	merging
747	212.60855	32.32913	212.60620	32.32945	15.76	15.85	-21.92	-21.50	8.96	0.62	19.24	0.0663	sp	merging
748	212.78265	6.93870	212.77802	6.94021	15.59	16.64	-22.87	-21.58	30.30	0.45	19.90	0.0964	sp	non-merging
749	212.94522	4.90718	212.94238	4.90696	16.85	16.95	-22.06	-21.76	20.85	0.31	20.78	0.1159	sp	non-merging
750	212.94937	54.96304	212.95660	54.95924	15.32	15.63	-22.50	-22.51	30.80	0.43	18.72	0.0832	sp	non-merging
751	213.13051	40.50343	213.11903	40.50058	15.64	16.12	-21.86	-21.73	49.51	0.18	18.21	0.0818	sp	non-merging
752	213.52763	26.99154	213.53641	26.99105	15.08	15.80	-22.77	-21.52	35.76	0.37	18.44	0.0681	sp	non-merging
753	213.63597	1.73160	213.63226	1.72965	14.73	14.98	-22.40	-21.81	15.17	0.57	17.92	0.0531	sp	non-merging
754	213.97482	29.45366	213.97491	29.45189	14.52	15.65	-24.12	-22.16	10.33	0.29	19.26	0.0891	ph	non-merging
755	214.29767	6.60260	214.29642	6.59813	15.61	16.90	-23.56	-21.95	33.61	0.73	19.67	0.1138	ph	non-merging
756	214.59549	49.60392	214.59529	49.59753	15.12	15.91	-22.66	-21.78	30.93	0.02	19.12	0.0726	sp	non-merging
757	214.84567	58.94827	214.83791	58.93945	15.24	15.52	-22.78	-22.33	48.23	0.68	18.73	0.0749	sp	non-merging
758	215.18091	25.14420	215.17485	25.14561	15.26	15.35	-22.69	-22.90	29.02	0.52	18.75	0.0773	sp	merging
759	215.25523	20.80075	215.25842	20.80277	16.63	16.77	-21.67	-21.78	23.98	0.26	20.02	0.1035	ph	non-merging
760	215.30486	43.05773	215.30540	43.06430	16.06	16.82	-22.42	-21.63	44.06	0.43	20.18	0.1042	sp	non-merging
761	215.31796	43.07083	215.31502	43.07376	16.23	16.91	-22.27	-21.75	24.18	0.33	20.55	0.1032	sp	non-merging
762	215.51570	-0.95710	215.51044	-0.95470	15.71	16.54	-22.46	-21.64	38.36	0.07	18.00	0.1030	sp	non-merging
763	215.55496	48.49830	215.54625	48.48990	14.47	15.09	-23.26	-22.19	42.16	0.29	17.77	0.0612	ph	non-merging
764	215.65872	64.08566	215.67056	64.08476	15.92	16.43	-22.50	-22.29	36.85	0.21	18.77	0.1099	sp	non-merging
765	215.79453	63.84631	215.79016	63.84659	16.54	17.06	-22.69	-21.50	13.75	0.00	21.95	0.1109	sp	non-merging
766	215.83896	56.68124	215.84325	56.68280	15.53	16.08	-23.18	-22.52	19.25	0.05	19.94	0.1062	sp	non-merging
767	215.86337	30.12775	215.85956	30.12731	16.80	16.82	-21.48	-21.59	21.67	0.59	20.27	0.1009	ph	non-merging
768	215.93474	6.60783	215.93721	6.60104	15.13	15.25	-21.86	-21.91	25.10	0.67	19.09	0.0508	sp	non-merging
769	215.97189	17.63063	215.97220	17.63412	15.62	17.27	-23.16	-21.36	25.26	0.66	19.58	0.1134	ph	merging
770	215.97966	17.57218	215.98146	17.56605	15.78	16.10	-22.68	-22.21	40.92	0.28	19.22	0.0993	ph	non-merging
771	216.01666	7.76104	216.02112	7.76028	14.87	15.24	-22.71	-22.19	17.29	1.17	17.25	0.0568	sp	merging
772	216.06326	25.07330	216.06049	25.06853	15.48	16.52	-23.02	-21.98	34.40	0.63	20.00	0.0987	sp	merging
773	216.15564	-1.63892	216.15808	-1.63228	14.89	15.40	-22.06	-21.64	26.59	0.28	18.48	0.0553	sp	non-merging
774	216.23915	4.57778	216.24411	4.57648	15.70	16.11	-23.00	-22.69	36.52	0.86	19.49	0.1122	sp	merging
775	216.74147	16.60056	216.73752	16.60376	15.69	16.55	-22.67	-21.50	29.93	0.17	18.58	0.0927	ph	non-merging
776	216.91937	11.72954	216.92366	11.73489	16.06	16.45	-22.73	-22.27	44.04	1.27	18.73	0.1004	sp	non-merging
777	217.07086	5.60189	217.07214	5.60026	16.05	16.71	-22.79	-22.02	14.74	0.45	20.79	0.1115	sp	non-merging
778	217.16495	6.35526	217.16156	6.35680	15.98	17.08	-22.67	-21.56	26.90	0.69	19.07	0.1144	sp	merging
779	217.22151	0.99287	217.22415	0.99597	16.66	17.16	-21.99	-21.41	29.29	0.16	20.61	0.1131	sp	non-merging
780	217.32350	-3.15181	217.32376	-3.15592	15.81	15.94	-22.16	-22.09	21.41	0.46	19.98	0.0787	ph	non-merging
781	217.77832	25.63370	217.77638	25.63066	15.33	16.25	-23.39	-22.13	21.11	0.24	18.57	0.0923	ph	non-merging
782	217.88423	24.70455	217.88332	24.70838	16.34	16.34	-22.07	-22.37	24.75	0.92	20.87	0.0975	sp	non-merging
783	218.02370	59.26093	218.01196	59.26110	16.44	17.12	-22.63	-21.55	43.43	0.85	18.52	0.1139	sp	merging
784	218.04199	5.43483	218.04388	5.44126	16.23	17.06	-22.60	-22.12	48.13	0.13	21.34	0.1129	sp	non-merging
785	218.18922	26.98771	218.18747	26.99137	16.03	16.67	-22.68	-21.66	24.79	0.85	18.83	0.0961	sp	merging
786	218.27216	19.78954	218.27335	19.79120	15.81	15.97	-23.35	-22.96	14.19	0.52	18.54	0.1113	ph	merging
787	218.27460	9.66933	218.27818	9.67257	14.70	16.15	-23.36	-21.94	27.17	0.11	18.97	0.0863	sp	non-merging
788	218.37236	61.38492	218.37517	61.38424	16.07	16.32	-22.58	-22.24	10.47	1.21	20.14	0.1085	sp	non-merging
789	218.44441	18.86500	218.44109	18.87100	15.21	15.84	-22.96	-22.06	33.47	0.78	17.19	0.0742	ph	merging
790	218.58313	61.54195	218.58542	61.53741	15.95	16.26	-23.21	-22.19	32.74	0.15	20.33	0.1098	sp	non-merging
791	218.60153	25.46500	218.60008	25.46051	16.49	16.53	-21.74	-21.65	28.57	0.56	19.63	0.0938	sp	non-merging
792	218.61681	26.33359	218.61122	26.33390	16.36	16.40	-21.67	-21.52	27.37	0.64	19.79	0.0829	ph	non-merging
793	218.62602	10.87599	218.63164	10.87569	15.58	16.47	-22.28	-21.52	31.11	0.38	20.04	0.0858	sp	non-merging
794	218.96907	42.67319	218.96306	42.67428	16.12	16.15	-21.60	-21.69	24.42	0.22	19.14	0.0812	sp	non-merging
795	219.02110	16.39788	219.01897	16.40200	15.86	16.13	-22.02	-21.91	25.63	0.61	20.01	0.0848	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
796	219.06447	-3.05229	219.06180	-3.05647	15.51	16.44	-22.99	-21.99	26.85	0.00	19.91	0.0821	sp	non-merging
797	219.18912	24.81036	219.18861	24.80658	16.28	16.40	-22.52	-22.54	27.87	0.37	20.43	0.1152	ph	non-merging
798	219.21861	5.08191	219.21513	5.08677	15.39	16.66	-22.76	-21.59	38.92	0.39	18.58	0.1011	sp	non-merging
799	219.22183	62.05556	219.22385	62.05386	15.47	16.45	-23.19	-22.21	14.08	0.53	19.58	0.1138	sp	merging
800	219.54260	62.73431	219.53441	62.73833	16.52	16.78	-21.69	-21.53	35.33	0.08	19.34	0.0995	ph	non-merging
801	219.62541	8.95259	219.62851	8.95787	15.35	16.19	-23.35	-22.19	37.84	0.28	18.88	0.0956	ph	non-merging
802	219.79094	29.21653	219.79277	29.21291	15.03	15.40	-22.51	-21.91	18.32	0.26	18.06	0.0691	sp	non-merging
803	219.84592	56.12293	219.85350	56.11856	15.81	16.51	-22.66	-22.06	41.06	0.70	18.30	0.1051	sp	merging
804	219.88426	27.22785	219.87701	27.23159	15.71	16.13	-22.46	-22.21	47.60	0.29	19.59	0.0988	ph	non-merging
805	220.00604	19.55060	220.00737	19.55138	15.81	16.04	-22.80	-22.24	8.89	0.13	17.98	0.0925	ph	non-merging
806	220.10439	18.81072	220.10352	18.80712	16.51	17.19	-22.31	-21.90	27.74	0.31	20.67	0.1190	ph	non-merging
807	220.39771	6.96490	220.40242	6.96425	15.97	16.45	-23.05	-22.44	34.65	0.60	18.97	0.1155	sp	merging
808	220.55333	33.98510	220.55133	33.98313	15.93	16.21	-22.79	-21.74	14.56	0.28	20.36	0.0862	sp	non-merging
809	220.57036	19.11798	220.57281	19.12485	15.81	16.53	-22.78	-22.18	48.97	0.66	19.72	0.1052	ph	non-merging
810	220.67804	31.75447	220.67773	31.75867	16.59	16.61	-21.68	-21.86	27.59	0.51	19.65	0.1015	sp	merging
811	220.83023	13.72726	220.83078	13.73159	16.98	17.22	-21.63	-21.33	32.87	0.32	20.16	0.1192	ph	non-merging
812	220.98856	25.27602	220.98709	25.27259	15.78	16.95	-23.01	-21.65	27.05	0.31	19.68	0.1162	sp	non-merging
813	221.12183	4.74474	221.12349	4.74703	14.82	15.23	-23.28	-22.81	15.71	0.79	17.30	0.0846	sp	merging
814	221.14381	20.42475	221.14174	20.42015	16.36	16.89	-22.47	-21.66	36.25	0.62	20.00	0.1143	ph	non-merging
815	221.15407	21.39347	221.15219	21.39594	16.91	17.07	-21.55	-21.71	21.90	0.90	20.22	0.1138	ph	non-merging
816	221.23537	46.21968	221.24309	46.21562	15.86	16.39	-22.27	-21.99	37.96	0.76	19.84	0.0861	sp	non-merging
817	221.33548	24.40085	221.33925	24.40196	16.17	16.35	-21.75	-22.38	21.55	0.00	20.42	0.0916	ph	non-merging
818	221.44513	24.23668	221.44656	24.24067	16.52	17.25	-22.40	-21.60	31.80	0.24	20.37	0.1199	ph	non-merging
819	221.56091	63.79825	221.56509	63.80108	16.90	17.08	-21.77	-21.53	24.19	0.38	20.80	0.1123	sp	non-merging
820	221.60472	21.70274	221.60538	21.69439	15.39	15.93	-23.92	-22.52	49.19	0.00	20.18	0.0899	ph	non-merging
821	221.94463	32.60585	221.94302	32.59854	15.51	16.30	-22.54	-21.56	42.41	0.43	19.50	0.0870	sp	non-merging
822	221.96075	46.55415	221.95552	46.55668	15.72	15.98	-22.22	-21.81	24.72	0.41	20.25	0.0856	sp	non-merging
823	222.08452	10.29023	222.07996	10.28589	15.67	16.30	-22.44	-21.54	33.54	0.35	19.62	0.0814	sp	non-merging
824	222.13100	23.98067	222.12820	23.97917	15.07	17.04	-24.60	-21.57	22.29	0.22	19.10	0.1193	sp	non-merging
825	222.31364	18.29502	222.30780	18.29112	16.25	16.87	-22.58	-21.77	47.38	0.19	20.03	0.1093	ph	non-merging
826	222.33923	4.82317	222.34386	4.82189	15.70	16.45	-22.34	-21.80	29.67	0.59	19.89	0.0955	sp	non-merging
827	222.34877	16.42908	222.34317	16.43250	15.39	15.58	-23.26	-23.29	44.57	0.44	19.05	0.1095	ph	non-merging
828	222.39391	11.24811	222.39558	11.24866	14.85	15.04	-23.11	-21.93	7.58	0.10	18.26	0.0649	ph	non-merging
829	222.42398	26.22010	222.42900	26.22508	16.03	16.94	-22.54	-21.42	44.85	0.30	20.30	0.1038	ph	non-merging
830	222.50504	57.28023	222.50269	57.27548	15.55	16.14	-22.08	-21.55	24.42	0.86	20.81	0.0746	sp	non-merging
831	222.57613	20.93736	222.57312	20.93648	15.91	16.99	-23.11	-21.92	21.79	0.52	19.57	0.1168	ph	non-merging
832	222.68153	23.15665	222.67751	23.15336	16.40	16.78	-22.41	-21.93	36.71	0.18	21.02	0.1169	sp	non-merging
833	223.05402	53.42517	223.05132	53.41820	16.04	16.35	-22.17	-21.70	44.23	0.41	19.51	0.0952	sp	non-merging
834	223.06442	50.37363	223.07314	50.37470	15.07	16.22	-23.81	-22.10	34.69	0.40	19.38	0.0943	sp	non-merging
835	223.22314	16.75201	223.22482	16.75036	15.65	15.68	-21.82	-21.76	10.68	0.43	19.23	0.0694	ph	non-merging
836	223.22963	54.93409	223.22240	54.94044	16.15	16.29	-22.25	-21.84	49.37	0.35	18.76	0.1008	sp	non-merging
837	223.23048	16.70286	223.24066	16.69709	14.27	14.72	-22.60	-21.94	37.17	0.60	17.24	0.0478	ph	merging
838	223.31584	31.11984	223.31290	31.11929	15.91	15.98	-21.97	-21.52	13.81	0.47	19.10	0.0811	sp	merging
839	223.33417	42.91214	223.33189	42.91568	15.64	16.76	-23.30	-22.05	28.56	0.42	20.72	0.1148	sp	non-merging
840	223.39255	5.96993	223.39339	5.97227	17.06	17.19	-21.75	-21.56	18.30	0.40	20.99	0.1163	ph	non-merging
841	223.67255	22.75580	223.67764	22.76041	16.06	17.18	-23.17	-21.54	47.95	0.46	20.65	0.1146	ph	non-merging
842	223.76508	54.32931	223.75740	54.32446	15.67	16.65	-22.84	-21.94	42.49	0.34	19.09	0.0996	sp	non-merging
843	223.77632	9.33770	223.77594	9.33662	16.74	17.05	-22.27	-21.86	8.47	0.74	20.67	0.1178	sp	non-merging
844	223.96310	29.89814	223.95938	29.90248	15.19	15.76	-22.35	-21.99	26.34	0.27	18.54	0.0730	ph	non-merging
845	223.99286	32.62572	223.98775	32.62796	15.87	16.45	-23.03	-21.98	26.88	0.26	19.05	0.0842	sp	non-merging
846	224.01701	47.39503	224.01697	47.39278	15.78	16.02	-22.37	-22.14	12.57	0.85	18.89	0.0851	sp	merging
847	224.16585	6.46071	224.16562	6.46474	14.31	14.80	-22.43	-21.57	12.24	0.95	17.13	0.0440	ph	merging
848	224.41493	53.00635	224.42691	53.00536	15.11	16.15	-23.25	-22.16	40.77	0.44	18.72	0.0853	sp	non-merging
849	224.56148	8.32234	224.56184	8.32571	16.26	16.87	-22.95	-21.75	24.44	0.04	18.82	0.1136	ph	non-merging
850	224.61581	48.49239	224.63452	48.48459	13.90	14.32	-22.30	-22.07	38.30	0.44	17.32	0.0376	sp	non-merging
851	224.63194	22.01463	224.62624	22.01298	16.57	16.87	-21.79	-21.60	37.69	0.39	20.80	0.1060	ph	non-merging
852	224.69875	37.98781	224.70290	37.98780	16.86	16.89	-21.69	-21.98	24.06	0.46	20.75	0.1160	ph	non-merging
853	224.80592	22.81085	224.80257	22.81433	16.83	17.03	-21.92	-21.63	34.56	0.03	18.99	0.1171	ph	non-merging
854	224.91254	57.93787	224.92430	57.93736	16.70	16.94	-21.65	-21.50	42.14	0.90	21.20	0.1047	sp	non-merging
855	224.98137	8.92715	224.98180	8.92309	16.87	17.00	-21.88	-21.74	30.84	0.21	20.66	0.1196	sp	non-merging
856	225.05200	48.70744	225.05717	48.70907	16.47	17.06	-22.40	-21.58	27.87	0.40	20.74	0.1161	sp	non-merging
857	225.13252	27.59306	225.13689	27.59634	15.94	16.46	-22.67	-22.10	35.23	0.09	19.28	0.1085	ph	non-merging
858	225.15863	45.20588	225.15804	45.20839	15.87	16.29	-22.27	-22.02	15.28	0.31	19.40	0.0921	sp	non-merging
859	225.17543	26.08859	225.18126	26.09000	16.78	16.89	-21.65	-21.58	36.03	1.39	19.80	0.1033	ph	merging
860	225.29820	2.11909	225.29922	2.12180	16.67	17.24	-22.52	-21.65	21.87	0.49	19.68	0.1194	sp	merging
861	225.30966	47.27369	225.30058	47.27325	15.16	15.28	-22.64	-22.53	26.97	0.24	17.99	0.0649	ph	non-merging
862	225.36414	39.23725	225.36078	39.23310	16.76	17.17	-22.12	-21.89	37.13	0.46	20.66	0.1200	sp	non-merging
863	225.39447	28.78752	225.39357	28.78244	16.27	16.70	-22.12	-21.73	35.26	0.44	18.95	0.1071	ph	non-merging
864	225.40784	18.61209	225.41422	18.61255	15.79	16.73	-22.68	-21.86	37.59	0.74	19.92	0.0955	ph	non-merging
865	225.66893	4.75500	225.66893	4.75173	16.44	17.12	-22.22	-21.64	23.71	0.95	20.17	0.1139	ph	non-merging
866	225.74948	1.31486	225.74634	1.30956	16.68	17.04	-22.19	-21.63	46.17	0.31	20.62	0.1186	sp	non-merging
867	225.78035	7.96565	225.78241	7.96274	16.18	16.43	-22.40	-21.94	20.94	0.19	19.98	0.0902	sp	non-merging
868	225.98277	4.40240	225.98129	4.40421	16.19	16.25	-21.90	-21.84	13.90	0.40	19.96	0.0912	sp	non-merging
869	226.06615	28.49655	226.07487	28.49523	13.92	15.26	-23.72	-22.00	26.80	0.70	18.23	0.0503	ph	non-merging
870	226.23801	26.01624	226.24306	26.01418	14.57	15.13	-23.00	-22.06	18.35	0.46	17.58	0.0540	ph	merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
871	226.35030	30.93364	226.35254	30.93685	16.53	16.69	-21.71	-21.49	22.67	0.29	21.50	0.0931	ph	non-merging
872	226.49774	27.32437	226.49718	27.32176	15.02	15.94	-24.15	-22.08	15.68	0.20	18.77	0.0903	ph	non-merging
873	226.50035	31.52966	226.49435	31.53527	15.60	16.23	-22.35	-21.47	39.65	0.15	19.91	0.0789	sp	non-merging
874	226.58684	3.70115	226.58681	3.70301	15.71	16.49	-22.45	-21.56	11.08	0.75	18.88	0.0916	sp	merging
875	226.68980	34.46658	226.69446	34.46284	16.39	17.25	-23.33	-21.53	39.51	0.00	21.48	0.1163	ph	non-merging
876	226.69978	25.48401	226.70439	25.48716	16.53	16.88	-22.13	-21.80	37.99	0.53	20.90	0.1146	sp	non-merging
877	226.92458	52.83340	226.92554	52.82869	16.45	16.89	-22.37	-22.10	35.65	0.52	20.82	0.1188	ph	non-merging
878	227.10733	-0.26627	227.10425	-0.26864	14.87	15.51	-23.69	-22.93	22.93	2.71	17.79	0.0903	sp	merging
879	227.13557	5.84303	227.13237	5.84507	15.99	16.12	-23.52	-22.72	25.31	0.00	21.63	0.1040	ph	non-merging
880	227.18724	7.85630	227.18300	7.85260	16.29	17.00	-22.36	-21.44	40.47	0.21	19.61	0.1137	sp	non-merging
881	227.29010	61.23154	227.28688	61.23072	15.72	16.07	-22.00	-21.53	8.73	0.35	19.47	0.0748	sp	non-merging
882	227.33511	7.63876	227.33730	7.63957	15.06	15.62	-23.75	-21.63	11.82	0.95	17.73	0.0772	sp	merging
883	227.34056	61.24274	227.33223	61.23529	15.36	16.05	-22.19	-21.45	40.78	0.13	18.63	0.0723	sp	non-merging
884	227.34087	-1.91284	227.33601	-1.91035	16.84	17.03	-21.78	-21.47	38.97	0.23	21.36	0.1122	sp	non-merging
885	227.39415	8.79762	227.39056	8.79296	16.59	16.79	-21.90	-22.42	38.03	0.13	20.18	0.1005	ph	non-merging
886	227.46883	22.54017	227.46568	22.53667	15.93	16.42	-23.01	-22.04	32.57	0.44	19.13	0.1125	ph	non-merging
887	227.48907	33.45417	227.48431	33.45219	15.91	17.18	-22.95	-21.66	33.18	0.23	19.77	0.1182	sp	non-merging
888	227.49750	3.00308	227.49847	3.00105	15.18	16.37	-23.58	-22.35	13.54	0.06	18.38	0.0920	sp	non-merging
889	227.54317	5.57114	227.53920	5.57241	15.80	16.32	-22.39	-21.85	22.60	0.84	18.01	0.0828	ph	merging
890	227.54741	-1.19531	227.55038	-1.19089	15.31	15.67	-22.50	-22.27	25.10	0.53	19.91	0.0705	sp	non-merging
891	227.54974	-2.24849	227.55347	-2.24325	14.35	15.76	-23.29	-22.16	34.97	0.20	17.64	0.0826	sp	non-merging
892	227.58382	33.48598	227.58469	33.49025	15.69	17.01	-22.86	-21.63	30.34	0.48	20.32	0.1095	sp	non-merging
893	227.74023	5.76614	227.74460	5.77080	16.44	16.44	-21.77	-21.58	35.84	0.00	20.57	0.0856	ph	non-merging
894	227.78011	10.54454	227.78539	10.53700	14.63	15.01	-23.02	-22.63	42.85	0.93	17.33	0.0700	sp	merging
895	227.83467	-0.12227	227.83015	-0.12126	16.11	16.35	-21.91	-21.76	27.00	0.47	18.66	0.0892	sp	merging
896	227.84798	-0.05927	227.85078	-0.06089	14.75	16.34	-23.90	-21.73	19.28	0.02	18.50	0.0911	sp	non-merging
897	227.87863	60.95664	227.87418	60.95794	15.11	15.73	-22.67	-21.99	12.32	0.47	17.62	0.0733	sp	merging
898	227.92931	6.07826	227.92899	6.06842	15.17	15.66	-22.66	-22.08	47.96	0.23	18.61	0.0730	ph	non-merging
899	228.01584	13.68780	228.01419	13.68977	16.06	16.46	-22.09	-21.20	14.19	0.29	20.72	0.0851	ph	non-merging
900	228.11725	7.97390	228.12505	7.97602	14.79	16.27	-23.17	-21.56	42.31	0.02	18.14	0.0799	sp	non-merging
901	228.23042	28.19001	228.23666	28.19074	16.03	16.50	-22.61	-21.99	41.13	0.21	19.39	0.1170	ph	non-merging
902	228.27100	15.56035	228.26912	15.55942	17.02	17.20	-21.91	-21.62	14.86	0.10	20.92	0.1154	ph	non-merging
903	228.33394	18.93726	228.34132	18.93351	15.93	15.95	-22.11	-21.80	42.61	0.20	19.30	0.0815	ph	non-merging
904	228.35901	5.66149	228.36313	5.66143	14.42	15.48	-22.54	-21.77	15.91	0.52	17.60	0.0571	ph	merging
905	228.46120	25.34586	228.46088	25.33931	15.46	16.48	-23.01	-21.47	37.02	0.37	19.89	0.0859	sp	non-merging
906	228.50177	6.72065	228.49835	6.72470	16.21	17.06	-22.71	-22.02	39.69	0.38	19.14	0.1189	ph	non-merging
907	228.51408	17.46572	228.51988	17.45788	15.67	15.81	-22.21	-22.02	47.85	0.54	19.98	0.0750	ph	non-merging
908	228.55782	28.07516	228.56096	28.06983	16.11	16.50	-22.43	-21.79	41.45	0.42	19.74	0.1079	ph	non-merging
909	228.56119	23.45233	228.56366	23.45206	15.34	16.43	-22.79	-21.52	13.29	0.37	19.77	0.0889	sp	non-merging
910	228.65448	27.15173	228.66333	27.14553	16.09	16.12	-21.56	-21.53	49.74	0.15	20.81	0.0746	ph	non-merging
911	228.80312	4.37484	228.80290	4.37618	16.22	16.64	-22.10	-22.05	8.88	0.02	21.04	0.1008	sp	non-merging
912	228.82292	4.39696	228.81746	4.39870	15.29	15.80	-22.92	-22.53	36.31	0.02	19.62	0.0981	sp	non-merging
913	228.84138	8.18166	228.83847	8.17876	15.38	16.26	-22.70	-21.77	21.60	0.66	19.72	0.0798	sp	non-merging
914	229.08408	3.02705	229.07962	3.02263	16.23	16.97	-22.48	-21.65	44.96	0.07	20.33	0.1125	sp	non-merging
915	229.10512	2.96734	229.10054	2.96509	16.58	16.64	-22.43	-22.06	36.76	0.41	20.10	0.1134	sp	non-merging
916	229.10931	18.91606	229.10233	18.91646	16.05	16.56	-22.08	-21.63	41.09	0.47	19.99	0.0956	ph	non-merging
917	229.21739	-0.90291	229.21516	-0.89930	16.23	17.19	-22.17	-21.62	31.11	0.41	19.09	0.1156	sp	non-merging
918	229.23947	2.61453	229.23961	2.62004	16.90	17.01	-21.95	-21.94	40.38	0.31	20.69	0.1155	ph	non-merging
919	229.29451	33.36480	229.29509	33.36752	15.63	16.76	-23.24	-21.97	20.12	0.69	19.12	0.1145	ph	merging
920	229.33673	50.55268	229.34094	50.55066	15.89	16.14	-21.60	-21.37	16.66	0.37	18.58	0.0746	sp	non-merging
921	229.35780	12.94588	229.36040	12.94623	15.15	16.58	-22.99	-21.41	14.76	0.50	19.51	0.0883	ph	non-merging
922	229.46590	59.85411	229.45447	59.85805	15.55	16.05	-22.08	-21.56	34.51	0.12	18.85	0.0745	sp	non-merging
923	229.50504	26.85703	229.51018	26.86237	15.61	16.41	-22.56	-21.59	40.11	0.23	19.25	0.0869	ph	non-merging
924	229.59691	5.20485	229.60170	5.20052	16.05	16.09	-22.47	-22.39	41.07	0.02	20.02	0.0985	ph	non-merging
925	229.66908	6.23836	229.67426	6.23893	15.72	16.73	-22.78	-21.86	33.92	0.21	19.52	0.1017	ph	non-merging
926	229.74469	6.15448	229.74600	6.14973	16.67	16.94	-21.84	-21.88	33.49	0.02	19.33	0.1060	ph	non-merging
927	229.74921	28.35493	229.74364	28.35171	16.32	16.88	-22.05	-21.68	41.88	0.46	18.84	0.1120	ph	non-merging
928	229.79530	59.11119	229.79108	59.11938	15.36	15.73	-22.35	-22.03	42.02	0.17	18.90	0.0746	sp	non-merging
929	229.94955	27.77268	229.95062	27.77784	15.98	15.99	-22.57	-21.80	27.64	0.65	18.48	0.0797	ph	merging
930	229.96619	30.18706	229.95770	30.18900	15.32	15.48	-22.49	-22.32	40.35	0.65	18.46	0.0805	sp	merging
931	229.97040	1.59177	229.96597	1.59270	15.33	15.45	-22.40	-22.15	23.46	0.32	18.50	0.0784	ph	non-merging
932	229.99155	51.31306	229.99115	51.31927	14.78	15.43	-23.02	-22.18	31.52	0.45	17.98	0.0764	sp	non-merging
933	230.09721	4.16167	230.09821	4.16191	16.70	16.97	-21.96	-21.82	7.05	0.76	20.30	0.1083	sp	non-merging
934	230.10371	7.82137	230.10434	7.82002	15.78	16.97	-23.20	-21.75	9.90	0.07	18.29	0.1033	ph	non-merging
935	230.19362	13.25552	230.19823	13.25293	15.07	16.19	-23.24	-22.38	31.53	1.40	18.02	0.0935	ph	merging
936	230.21951	33.67269	230.21614	33.67929	15.83	16.81	-22.57	-21.66	48.15	0.98	19.56	0.1045	sp	non-merging
937	230.22438	45.32136	230.21205	45.32089	15.34	15.39	-21.73	-21.86	37.25	0.16	18.17	0.0637	sp	non-merging
938	230.27164	29.42395	230.27037	29.42341	15.44	16.70	-23.41	-21.48	8.13	0.73	19.77	0.1028	ph	non-merging
939	230.29999	8.19370	230.30516	8.19552	15.23	16.08	-22.75	-21.94	27.42	0.13	18.91	0.0760	sp	non-merging
940	230.33110	2.51757	230.33363	2.52662	14.91	15.64	-23.32	-22.47	44.57	0.27	17.87	0.0711	ph	non-merging
941	230.37669	21.19060	230.37788	21.19263	13.74	14.70	-23.01	-21.87	8.03	0.35	17.88	0.0506	ph	non-merging
942	230.40855	5.33085	230.41252	5.32937	16.72	16.75	-22.10	-21.50	26.94	0.30	21.02	0.0987	ph	non-merging
943	230.49799	12.76428	230.49857	12.76140	16.67	17.18	-22.30	-21.32	21.12	0.54	19.50	0.1130	ph	merging
944	230.51865	27.41635	230.51631	27.42068	16.57	16.62	-21.82	-21.91	31.63	0.26	20.20	0.1022	ph	non-merging
945	230.53111	6.03446	230.52477	6.03701	15.90	16.41	-22.58	-22.23	45.87	0.19	18.82	0.1049	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
946	230.54797	27.63265	230.55589	27.63510	15.88	16.02	-22.05	-21.78	40.82	0.21	19.99	0.0835	ph	non-merging
947	230.62157	27.70763	230.62047	27.71242	15.10	15.31	-23.28	-22.60	25.37	0.25	17.69	0.0785	ph	non-merging
948	230.68353	27.61748	230.68800	27.61408	15.78	16.73	-22.69	-21.69	33.12	0.26	20.52	0.0980	ph	non-merging
949	230.74257	6.74308	230.74078	6.73993	14.97	16.29	-23.15	-21.87	20.82	0.49	19.20	0.0879	ph	merging
950	230.77539	4.22274	230.77097	4.22209	16.36	16.61	-22.28	-22.12	30.94	0.50	18.91	0.1084	sp	merging
951	230.79684	31.02127	230.79735	31.01733	15.76	16.38	-23.29	-22.22	28.88	0.74	18.58	0.1146	sp	merging
952	231.22862	66.02891	231.23357	66.03359	16.14	16.62	-23.42	-21.80	32.56	0.00	20.22	0.0987	ph	non-merging
953	231.43466	37.83259	231.43341	37.83535	16.20	16.42	-22.28	-22.01	20.46	0.76	19.00	0.1093	sp	merging
954	231.47438	5.73603	231.47392	5.74102	15.68	17.06	-23.25	-21.87	36.97	0.57	19.57	0.1161	ph	non-merging
955	231.47728	28.46342	231.47174	28.45909	15.47	15.71	-22.89	-22.84	40.91	0.17	18.39	0.0969	ph	non-merging
956	231.64490	26.33423	231.64899	26.33539	16.29	16.40	-22.60	-22.17	26.82	0.29	19.70	0.1091	ph	non-merging
957	231.72090	0.84855	231.71753	0.84985	16.52	16.70	-22.38	-22.23	26.84	0.32	20.46	0.1173	sp	non-merging
958	231.96915	2.29966	231.96663	2.30412	16.98	17.17	-21.55	-21.59	37.87	0.23	20.43	0.1167	ph	non-merging
959	232.22443	1.72649	232.22633	1.72885	15.11	15.56	-23.09	-22.49	17.80	0.70	19.90	0.0900	ph	non-merging
960	232.29233	20.04289	232.28906	20.04519	16.81	16.83	-21.65	-21.68	26.53	0.22	19.77	0.1083	sp	non-merging
961	232.32573	63.74924	232.31694	63.74577	16.63	16.79	-21.95	-21.80	35.22	0.83	19.49	0.1052	ph	merging
962	232.61577	14.25516	232.61958	14.25652	16.63	17.11	-21.94	-21.60	29.16	0.70	20.94	0.1169	ph	non-merging
963	232.66275	3.49402	232.66527	3.49855	14.50	15.86	-23.71	-22.02	29.42	0.09	17.41	0.0865	sp	non-merging
964	232.70993	3.49531	232.71033	3.49911	17.05	17.14	-21.60	-21.55	28.79	0.00	30.71	0.1191	sp	non-merging
965	232.84276	14.72092	232.83540	14.72081	15.21	15.28	-22.23	-22.01	29.98	0.27	18.57	0.0624	ph	non-merging
966	233.04036	58.90509	233.04771	58.90784	14.69	15.60	-23.12	-21.82	21.41	0.02	18.71	0.0681	sp	non-merging
967	233.26257	0.28370	233.25665	0.28382	15.12	16.10	-22.62	-21.74	30.35	0.16	19.01	0.0773	ph	non-merging
968	233.33067	28.07210	233.33669	28.06707	16.29	15.76	-21.43	-22.10	39.49	0.26	20.05	0.0819	ph	non-merging
969	233.38774	9.65981	233.38820	9.66134	16.25	16.46	-22.12	-21.97	10.72	0.38	19.93	0.1046	sp	non-merging
970	233.53575	7.50969	233.53432	7.51589	16.17	16.51	-22.74	-22.11	47.86	0.55	19.22	0.1188	sp	merging
971	233.57332	8.62151	233.57294	8.61795	16.03	16.57	-22.37	-21.90	23.61	0.31	20.24	0.1026	sp	non-merging
972	233.87285	6.29057	233.87621	6.28770	14.80	15.58	-22.36	-21.52	19.30	0.18	17.56	0.0652	ph	non-merging
973	233.90337	11.75513	233.90361	11.75826	15.91	16.25	-22.39	-22.33	19.55	0.84	19.25	0.0959	ph	merging
974	234.28442	11.29923	234.27931	11.29994	16.91	16.93	-21.70	-21.66	36.41	0.28	20.22	0.1130	ph	non-merging
975	234.34161	22.38934	234.33830	22.39392	15.52	17.14	-23.86	-21.66	41.25	0.63	19.92	0.1183	ph	non-merging
976	234.63281	40.82878	234.63048	40.82810	15.53	16.19	-22.95	-21.84	11.79	1.43	18.85	0.0961	sp	merging
977	234.64215	21.38927	234.64026	21.38748	16.06	16.70	-22.15	-21.49	15.50	0.23	19.73	0.0950	ph	non-merging
978	234.76469	43.32304	234.76018	43.32059	15.23	15.64	-22.01	-21.39	16.19	0.46	18.60	0.0582	sp	merging
979	235.12256	8.08447	235.12523	8.08277	15.73	16.30	-23.21	-22.66	23.43	0.77	19.45	0.1179	ph	non-merging
980	235.36046	4.73200	235.35934	4.73721	15.48	16.00	-23.02	-22.98	33.28	0.54	18.35	0.0964	ph	non-merging
981	235.39362	55.97747	235.39873	55.97775	15.19	15.26	-22.50	-22.16	13.07	0.26	18.34	0.0679	sp	non-merging
982	235.41676	35.71690	235.40945	35.71433	16.51	16.75	-22.25	-21.98	48.25	0.58	20.80	0.1179	sp	non-merging
983	235.45355	1.44732	235.45129	1.44492	16.45	16.52	-22.35	-21.78	20.50	0.00	21.22	0.0959	ph	non-merging
984	235.47037	25.33570	235.46411	25.33318	14.94	15.22	-22.69	-22.38	28.07	0.49	18.99	0.0676	sp	merging
985	235.53348	29.88134	235.53984	29.88691	15.88	16.21	-22.08	-21.60	42.78	0.43	18.58	0.0828	sp	non-merging
986	235.57982	11.05237	235.58073	11.05858	15.91	16.07	-22.14	-21.97	35.26	0.17	19.00	0.0855	ph	non-merging
987	235.59198	11.06144	235.60077	11.06462	15.58	15.91	-22.58	-21.98	48.86	0.02	18.52	0.0804	ph	non-merging
988	235.69165	61.84357	235.68405	61.84979	16.35	17.03	-22.45	-21.63	48.89	0.87	20.29	0.1062	ph	non-merging
989	235.76698	5.77206	235.76793	5.77597	15.69	16.44	-23.84	-22.38	27.35	0.07	19.66	0.1061	ph	non-merging
990	235.78751	42.16656	235.78349	42.16370	16.26	16.98	-23.11	-21.65	27.68	0.00	21.75	0.1044	sp	non-merging
991	235.94228	34.25600	235.94601	34.25568	16.20	16.79	-23.03	-22.24	23.09	0.65	18.78	0.1173	sp	merging
992	236.03816	3.49178	236.04311	3.48753	15.79	16.74	-22.91	-21.94	46.14	0.38	20.70	0.1111	sp	non-merging
993	236.11880	8.40815	236.11626	8.41303	15.50	16.97	-23.00	-21.87	40.35	0.10	19.30	0.1158	ph	non-merging
994	236.26100	36.15634	236.26456	36.16753	15.47	15.52	-21.72	-21.87	47.21	0.13	18.81	0.0604	sp	non-merging
995	236.41196	15.04953	236.41579	15.04953	15.79	15.93	-21.75	-21.63	17.41	0.69	18.70	0.0704	ph	merging
996	236.46442	30.66810	236.45851	30.66573	15.92	16.70	-23.19	-22.10	39.99	0.46	19.48	0.1120	sp	non-merging
997	236.54691	47.95174	236.54482	47.95371	16.78	16.94	-22.04	-21.76	18.00	1.13	20.66	0.1178	sp	non-merging
998	236.59190	47.65050	236.58488	47.64898	15.71	16.65	-23.30	-22.43	36.57	0.61	18.72	0.1161	sp	merging
999	236.65347	18.76111	236.65558	18.75776	15.53	15.83	-23.14	-22.94	27.01	0.34	20.03	0.1084	sp	non-merging
1000	236.68456	55.01343	236.68338	55.02019	16.07	17.02	-23.36	-21.80	46.39	0.68	20.11	0.1065	sp	non-merging
1001	236.68463	3.69888	236.68454	3.69208	15.90	16.46	-22.77	-21.86	43.08	0.56	19.32	0.0978	sp	non-merging
1002	236.70543	3.27742	236.70432	3.28125	15.52	15.91	-23.38	-22.51	24.89	1.48	20.25	0.0962	sp	non-merging
1003	237.01788	34.64726	237.01973	34.64938	15.55	15.99	-21.96	-21.54	12.40	0.33	18.18	0.0713	sp	non-merging
1004	237.10091	31.56587	237.10173	31.56281	16.54	17.17	-22.14	-21.52	22.40	0.53	21.15	0.1119	sp	non-merging
1005	237.22949	45.05866	237.23343	45.05627	16.23	16.46	-23.10	-22.84	27.59	0.00	19.81	0.1190	sp	non-merging
1006	237.26826	-1.93108	237.26927	-1.92543	16.56	16.76	-22.68	-22.23	41.81	0.37	20.69	0.1146	ph	non-merging
1007	237.32042	21.81941	237.32004	21.82343	14.70	14.97	-22.55	-22.17	15.74	0.67	18.23	0.0575	ph	merging
1008	237.32657	25.65440	237.31665	25.65818	15.40	15.93	-21.99	-21.43	43.74	0.45	19.58	0.0671	sp	merging
1009	237.45262	29.17599	237.44431	29.17574	15.44	15.73	-23.35	-22.86	40.35	0.71	19.23	0.0845	ph	merging
1010	237.51805	29.19437	237.52408	29.19429	15.69	16.08	-22.29	-22.08	28.50	0.16	18.62	0.0821	sp	non-merging
1011	237.70790	48.07588	237.71138	48.08099	16.48	17.04	-22.06	-21.62	39.89	0.27	19.04	0.1113	sp	non-merging
1012	237.79393	28.41492	237.79129	28.42014	15.18	16.07	-23.59	-22.83	35.12	0.86	17.57	0.0946	sp	merging
1013	237.83490	32.89637	237.83348	32.89490	16.24	17.17	-22.50	-21.51	13.59	0.47	20.19	0.1129	sp	non-merging
1014	237.87569	18.40483	237.87454	18.40872	14.92	16.44	-23.54	-22.43	27.85	0.42	19.56	0.1077	ph	non-merging
1015	237.90567	45.55448	237.90552	45.55241	16.28	16.51	-22.67	-22.64	15.41	0.64	19.50	0.1170	sp	merging
1016	237.99890	13.43828	238.00589	13.43865	15.85	15.95	-21.84	-21.54	32.33	0.22	19.08	0.0711	ph	non-merging
1017	238.01677	23.03696	238.02211	23.03571	17.07	17.23	-21.66	-21.46	37.21	0.00	22.70	0.1156	sp	non-merging
1018	238.03049	5.80616	238.03178	5.80855	16.45	16.52	-22.08	-22.02	20.19	0.17	19.74	0.1175	sp	non-merging
1019	238.03796	20.09673	238.03830	20.08979	15.74	16.48	-22.49	-21.71	43.37	0.43	19.14	0.0962	ph	non-merging
1020	238.23366	12.68210	238.22862	12.68335	16.77	16.86	-21.73	-21.50	33.50	0.39	19.28	0.1026	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
1021	238.40259	17.80540	238.39549	17.80056	16.11	16.23	-22.45	-22.14	49.73	0.20	19.22	0.0918	sp	non-merging
1022	238.60289	24.18507	238.59596	24.18502	16.57	17.21	-22.17	-21.55	47.15	0.31	21.53	0.1179	sp	non-merging
1023	238.62473	7.32150	238.62422	7.31924	16.11	16.28	-23.31	-21.94	15.12	0.34	20.88	0.1013	sp	non-merging
1024	238.67528	45.34425	238.68704	45.33826	14.12	14.68	-22.48	-21.77	28.38	1.06	17.08	0.0401	sp	merging
1025	238.81140	24.84760	238.81508	24.84484	15.36	15.87	-22.48	-21.90	24.69	0.53	17.91	0.0869	sp	merging
1026	238.83284	33.24817	238.84111	33.24886	15.99	16.70	-22.09	-21.57	42.40	0.15	19.51	0.0938	sp	non-merging
1027	238.87608	30.44887	238.87018	30.44485	16.79	17.18	-21.77	-21.50	47.54	0.46	20.33	0.1155	ph	non-merging
1028	239.13144	19.16778	239.12900	19.16858	16.07	16.16	-21.97	-21.77	13.06	2.08	18.66	0.0810	ph	merging
1029	239.19527	25.85706	239.19304	25.86073	14.86	15.33	-22.81	-22.33	20.44	0.35	19.26	0.0733	ph	non-merging
1030	239.57805	27.23911	239.58334	27.23342	16.49	14.70	-21.95	-23.58	41.54	0.36	19.28	0.0857	sp	non-merging
1031	239.78940	26.91943	239.78812	26.91449	15.99	16.21	-22.09	-21.97	28.87	0.13	19.40	0.0870	sp	non-merging
1032	239.91515	21.19610	239.91818	21.20239	16.70	16.92	-21.67	-21.48	47.17	0.51	21.31	0.1067	sp	non-merging
1033	240.28694	60.95949	240.28014	60.96395	16.06	16.33	-22.53	-22.39	37.18	0.76	19.48	0.1041	ph	merging
1034	240.36700	53.94738	240.36786	53.93642	14.30	15.88	-23.99	-22.14	48.22	0.00	19.40	0.0654	sp	non-merging
1035	240.51828	26.96303	240.51657	26.96087	15.92	15.98	-22.60	-22.64	17.75	0.53	19.91	0.1046	sp	merging
1036	240.72946	36.35216	240.73111	36.34993	15.56	15.82	-21.77	-21.68	11.78	0.37	19.71	0.0675	sp	non-merging
1037	240.81593	8.13237	240.81496	8.13038	16.03	16.62	-22.91	-21.76	14.96	0.80	19.88	0.1052	sp	merging
1038	240.83188	38.25779	240.83076	38.25364	15.85	16.38	-22.28	-22.13	28.10	0.77	18.94	0.1028	sp	merging
1039	241.09955	11.04346	241.09912	11.04208	16.15	16.33	-22.05	-21.74	8.23	0.33	20.37	0.0872	ph	non-merging
1040	241.10849	11.08344	241.11090	11.08089	15.66	15.76	-21.90	-22.01	17.62	0.41	19.07	0.0764	ph	non-merging
1041	241.36089	54.99442	241.35229	54.99805	15.41	15.50	-21.69	-21.53	24.67	0.84	19.76	0.0596	ph	non-merging
1042	241.37157	16.43586	241.36014	16.44275	13.80	14.22	-22.82	-22.48	40.33	0.37	17.56	0.0452	sp	non-merging
1043	241.37436	19.40984	241.37294	19.40880	15.86	16.60	-23.11	-22.14	12.36	0.79	19.96	0.1150	ph	non-merging
1044	241.44522	37.98212	241.44240	37.98540	16.20	16.91	-22.09	-21.34	26.32	0.20	20.26	0.1031	sp	non-merging
1045	241.65500	23.87691	241.65959	23.87622	15.00	16.40	-23.34	-22.15	26.82	0.23	17.99	0.0973	sp	non-merging
1046	241.66371	0.03297	241.66374	0.03493	15.73	16.17	-22.70	-21.93	10.93	0.97	19.99	0.0848	ph	merging
1047	242.03262	42.98526	242.03403	42.99059	16.24	16.61	-22.34	-21.76	36.65	0.17	19.27	0.1054	ph	non-merging
1048	242.09753	0.42690	242.09979	0.42510	16.13	16.37	-21.88	-21.56	16.66	0.61	19.49	0.0880	ph	merging
1049	242.23138	30.64670	242.22791	30.65047	15.89	16.16	-22.45	-21.96	29.22	0.24	19.00	0.0932	sp	non-merging
1050	242.45457	40.66863	242.45354	40.67023	16.81	17.00	-21.97	-21.68	13.10	0.39	20.84	0.1160	sp	non-merging
1051	242.92863	17.79082	242.92351	17.78594	15.39	16.31	-22.61	-21.77	37.70	0.12	18.84	0.0830	sp	non-merging
1052	242.93875	29.74721	242.93517	29.74824	15.62	15.63	-22.79	-22.58	18.32	0.74	17.38	0.0850	ph	merging
1053	243.20938	13.65261	243.19989	13.65343	15.50	15.71	-22.07	-21.93	45.58	0.21	18.16	0.0740	ph	non-merging
1054	243.42796	18.60187	243.43098	18.59697	16.31	16.69	-22.46	-21.61	39.60	0.68	19.67	0.1091	ph	merging
1055	243.49199	49.18960	243.50557	49.18304	14.80	15.63	-22.77	-21.78	44.83	0.00	20.30	0.0600	sp	non-merging
1056	243.61835	28.29195	243.61319	28.28793	15.80	16.64	-22.87	-21.99	41.27	0.55	20.67	0.1060	sp	non-merging
1057	243.63908	56.06924	243.62543	56.06985	15.35	15.93	-22.14	-21.58	35.75	0.31	19.37	0.0699	ph	non-merging
1058	243.72589	37.18713	243.72577	37.18512	15.02	15.05	-22.64	-22.31	7.96	0.93	17.52	0.0584	sp	merging
1059	243.80157	57.71391	243.80678	57.71019	15.46	15.84	-22.50	-22.10	24.69	0.42	19.54	0.0806	ph	non-merging
1060	244.03207	7.74160	244.03122	7.74289	16.02	16.35	-22.33	-21.86	9.78	0.17	19.11	0.0982	sp	non-merging
1061	244.12102	17.31548	244.11693	17.32075	15.66	16.19	-22.05	-21.62	33.69	0.75	19.66	0.0775	ph	merging
1062	244.19197	55.04247	244.19345	55.04548	16.26	16.82	-22.15	-21.67	20.68	0.85	21.09	0.1027	ph	non-merging
1063	244.50311	25.39309	244.50690	25.39729	16.01	16.03	-22.68	-22.53	38.70	0.43	19.12	0.1121	sp	non-merging
1064	244.54990	56.78514	244.55443	56.78121	15.44	15.78	-22.12	-21.65	20.26	0.49	20.27	0.0648	ph	non-merging
1065	244.67084	55.51764	244.66286	55.52039	16.28	16.69	-23.01	-22.16	38.80	0.24	19.28	0.1156	ph	non-merging
1066	244.75488	11.00602	244.75229	11.01263	15.86	16.05	-22.18	-22.45	45.20	0.44	18.83	0.0987	ph	non-merging
1067	244.80820	46.77468	244.81670	46.77584	15.67	16.36	-22.35	-21.52	31.95	0.40	19.48	0.0816	sp	non-merging
1068	244.81396	26.40847	244.81627	26.40444	15.96	16.46	-22.64	-22.17	32.25	0.84	20.54	0.1120	sp	non-merging
1069	244.85742	9.56379	244.86087	9.55864	16.24	17.07	-23.00	-21.69	46.20	0.00	20.54	0.1183	ph	non-merging
1070	244.93098	26.71178	244.92859	26.70862	16.27	16.29	-22.04	-21.73	23.40	0.14	18.96	0.0943	sp	non-merging
1071	245.07776	8.87219	245.07668	8.86687	16.21	16.70	-22.85	-22.22	40.60	1.81	18.93	0.1184	ph	non-merging
1072	245.48392	25.68863	245.48773	25.69153	16.72	16.76	-22.80	-22.13	28.98	0.94	20.22	0.0998	sp	non-merging
1073	245.67578	51.28322	245.68053	51.28091	15.18	15.50	-22.29	-21.62	15.18	0.17	18.36	0.0596	ph	non-merging
1074	246.01105	8.03278	246.01128	8.03157	16.08	16.93	-22.78	-21.67	9.08	0.42	20.42	0.1167	ph	non-merging
1075	246.03815	48.64325	246.04533	48.64359	15.30	16.48	-22.85	-21.52	28.11	0.45	19.48	0.0904	sp	non-merging
1076	246.07687	20.96955	246.07536	20.97408	15.20	15.95	-23.12	-22.57	30.65	0.49	18.72	0.0999	sp	merging
1077	246.09814	45.12042	246.10353	45.11554	16.94	17.12	-21.92	-21.40	45.31	0.66	20.38	0.1154	sp	non-merging
1078	246.18939	5.95906	246.18317	5.96310	15.40	16.46	-22.92	-21.65	42.28	0.22	19.54	0.0872	ph	non-merging
1079	246.31850	33.19344	246.31758	33.19626	15.82	17.28	-23.23	-21.65	21.95	0.73	19.10	0.1185	sp	non-merging
1080	246.54312	14.74193	246.54211	14.73909	16.40	16.59	-21.55	-21.49	17.69	0.20	20.03	0.0903	sp	non-merging
1081	246.66595	50.69655	246.66417	50.69558	16.67	16.77	-22.25	-22.21	11.10	0.20	19.83	0.1177	ph	non-merging
1082	246.69788	50.69717	246.68730	50.69709	15.85	16.47	-22.68	-22.19	44.81	0.15	19.35	0.1040	ph	non-merging
1083	246.88513	27.25772	246.88258	27.25811	16.45	17.23	-23.04	-21.99	16.33	0.00	20.80	0.1115	sp	non-merging
1084	247.03415	7.35955	247.03670	7.36379	15.64	16.17	-22.23	-21.77	27.96	0.29	19.65	0.0862	ph	non-merging
1085	247.17235	28.02481	247.16876	28.02401	16.51	17.00	-22.27	-22.08	24.20	0.15	19.68	0.1170	sp	non-merging
1086	248.18253	49.37279	248.17168	49.37135	15.70	16.48	-22.77	-21.65	48.67	0.22	19.74	0.1051	ph	non-merging
1087	248.21898	12.88054	248.22505	12.88631	15.64	15.68	-22.43	-22.17	46.35	0.59	18.56	0.0853	sp	merging
1088	248.27133	11.76139	248.27222	11.75901	14.48	15.78	-23.93	-21.51	11.83	0.00	20.84	0.0699	ph	non-merging
1089	248.68349	21.97861	248.68915	21.97429	15.67	15.68	-22.57	-22.84	42.04	0.61	19.41	0.0952	sp	non-merging
1090	249.02278	32.65861	249.01509	32.65554	15.65	16.79	-23.27	-21.93	46.24	0.00	21.02	0.0998	sp	non-merging
1091	249.20293	41.89416	249.19472	41.88770	15.18	15.70	-22.60	-22.33	46.14	0.60	18.94	0.0784	sp	merging
1092	249.50357	27.57087	249.50737	27.57019	16.39	16.85	-21.83	-21.59	23.66	0.97	19.73	0.1075	ph	merging
1093	249.51524	26.72517	249.51678	26.72474	15.96	16.37	-22.49	-21.76	8.92	0.67	19.93	0.0952	ph	non-merging
1094	249.75737	29.76262	249.76247	29.76542	15.78	16.45	-22.55	-21.56	30.09	0.21	19.14	0.0877	sp	non-merging
1095	249.83385	29.84883	249.83308	29.85053	14.78	15.94	-23.74	-21.65	10.35	0.41	19.37	0.0868	ph	non-merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
1096	250.08893	40.75524	250.09189	40.75037	16.06	16.93	-22.36	-21.59	35.90	0.58	20.69	0.1043	sp	non-merging
1097	250.38387	24.09065	250.38744	24.08665	16.26	16.83	-21.78	-21.50	33.41	0.16	19.13	0.1003	sp	non-merging
1098	251.26759	35.30721	251.27028	35.30883	16.05	16.68	-22.64	-21.67	19.79	0.63	19.00	0.1140	ph	merging
1099	251.43486	50.01088	251.44400	50.01458	14.64	15.13	-23.65	-23.58	42.94	0.86	17.51	0.0952	ph	non-merging
1100	252.21599	38.77087	252.21379	38.76821	17.21	17.29	-21.59	-21.32	23.73	0.46	21.31	0.1185	ph	non-merging
1101	252.77428	27.79865	252.77003	27.79932	16.46	16.58	-22.17	-22.19	26.92	0.63	20.17	0.1107	sp	non-merging
1102	252.83621	32.37077	252.83574	32.36868	15.86	16.18	-22.28	-22.08	12.18	1.45	19.38	0.0869	sp	merging
1103	253.47974	44.17297	253.47908	44.17059	16.55	16.70	-23.38	-21.60	16.01	0.38	19.57	0.1028	ph	non-merging
1104	253.57262	37.62238	253.56097	37.62618	14.36	15.40	-23.23	-22.08	43.51	0.42	18.53	0.0649	sp	non-merging
1105	253.88789	38.06485	253.88199	38.06286	16.14	16.48	-22.96	-22.59	36.88	2.84	18.73	0.1149	ph	non-merging
1106	254.03525	38.29171	254.03841	38.29419	16.45	16.65	-22.21	-22.32	25.83	0.76	18.92	0.1161	sp	merging
1107	254.16574	18.51075	254.17314	18.51366	16.20	16.31	-21.55	-21.78	40.60	0.19	19.22	0.0810	sp	non-merging
1108	254.28751	48.03094	254.28040	48.02500	15.26	15.70	-22.68	-22.27	41.54	0.29	19.25	0.0829	ph	non-merging
1109	254.41968	40.72236	254.41612	40.70732	13.86	13.87	-21.90	-21.93	32.75	0.45	18.13	0.0306	sp	non-merging
1110	254.71735	63.17952	254.71591	63.17645	15.85	15.95	-22.62	-22.43	20.22	0.06	18.61	0.1000	sp	non-merging
1111	254.74515	42.66385	254.74483	42.66500	16.05	16.57	-22.45	-21.65	7.43	1.33	20.73	0.0971	ph	non-merging
1112	254.86977	30.48376	254.86914	30.48620	16.73	16.90	-22.31	-21.60	17.59	0.85	20.37	0.1105	ph	non-merging
1113	255.53001	62.07434	255.52695	62.07991	16.20	16.73	-22.32	-21.62	39.96	0.27	19.01	0.1088	sp	non-merging
1114	255.55560	39.03723	255.56065	39.04506	16.20	16.36	-21.79	-21.54	47.95	0.07	19.54	0.0831	sp	non-merging
1115	255.55669	38.19928	255.56520	38.19994	16.77	16.93	-21.61	-21.71	48.01	0.30	20.10	0.1121	sp	non-merging
1116	255.60248	33.50311	255.59880	33.49702	15.38	16.26	-23.10	-21.70	37.67	0.85	18.31	0.0840	sp	non-merging
1117	255.62807	34.04187	255.62964	34.03900	16.10	16.72	-22.28	-21.61	20.24	0.20	19.28	0.0993	sp	non-merging
1118	255.66383	33.51410	255.65694	33.52089	15.68	16.37	-22.40	-21.93	49.43	0.32	19.57	0.0845	sp	non-merging
1119	255.93855	30.50901	255.93086	30.50971	16.29	16.86	-22.14	-21.72	44.97	0.07	18.80	0.1051	ph	non-merging
1120	256.01096	33.86885	256.00888	33.87057	15.88	16.25	-22.54	-22.03	14.53	1.92	19.01	0.0913	sp	merging
1121	256.37222	22.26877	256.35831	22.27164	13.81	15.12	-23.19	-21.22	44.33	0.17	17.41	0.0490	sp	non-merging
1122	256.52911	19.03340	256.53674	19.03666	15.22	16.24	-23.81	-21.83	41.73	0.62	19.10	0.0798	ph	merging
1123	256.75662	23.57385	256.75571	23.57227	16.67	16.98	-22.26	-21.90	13.16	0.65	19.68	0.1163	sp	non-merging
1124	256.80829	19.68301	256.80963	19.67749	15.92	16.66	-22.32	-21.68	36.18	0.40	19.26	0.0988	ph	non-merging
1125	256.84048	33.38821	256.83276	33.38866	15.87	16.40	-22.87	-22.29	41.96	0.00	19.99	0.1006	sp	non-merging
1126	257.17389	33.45099	257.17734	33.45800	16.40	16.49	-22.01	-21.75	49.83	0.27	20.40	0.1020	sp	non-merging
1127	257.63409	33.48524	257.63156	33.49020	15.96	16.86	-22.57	-21.74	37.60	0.33	20.19	0.1092	sp	non-merging
1128	257.70099	39.48326	257.70578	39.48574	15.59	16.27	-22.26	-21.67	24.00	1.41	19.45	0.0817	ph	merging
1129	257.75528	39.69049	257.74863	39.69480	14.69	16.40	-23.70	-22.03	41.15	0.80	18.57	0.0946	ph	non-merging
1130	258.06747	64.03677	258.08054	64.03562	15.51	15.86	-22.37	-21.78	31.71	0.27	18.80	0.0825	sp	non-merging
1131	258.19138	29.28760	258.19626	29.29298	16.93	16.97	-21.47	-21.56	46.29	0.20	20.13	0.1051	sp	non-merging
1132	258.20016	27.54950	258.20419	27.54752	15.88	16.28	-22.57	-21.93	23.49	0.11	19.45	0.0879	ph	non-merging
1133	258.32935	64.07687	258.31345	64.07335	15.05	15.26	-22.65	-22.45	41.72	0.59	18.99	0.0811	sp	merging
1134	258.36627	39.71220	258.35709	39.71846	15.56	15.71	-21.80	-21.68	42.54	0.15	19.05	0.0671	ph	non-merging
1135	258.56393	41.78653	258.56729	41.79477	15.25	15.30	-22.83	-23.30	44.96	0.99	17.55	0.0789	ph	merging
1136	259.04489	21.91468	259.04355	21.91394	15.95	16.08	-23.14	-22.39	10.05	0.65	20.58	0.1084	ph	non-merging
1137	259.06375	28.01401	259.06506	28.00965	15.83	16.83	-23.07	-22.41	31.03	0.13	18.74	0.1074	sp	non-merging
1138	259.08484	28.00562	259.08096	28.00879	16.36	17.07	-22.29	-21.52	32.22	0.26	20.31	0.1080	sp	non-merging
1139	259.22958	76.25295	259.22421	76.25070	16.56	16.74	-22.29	-21.50	17.62	0.38	20.12	0.1062	ph	non-merging
1140	260.15018	56.66183	260.15707	56.66256	16.21	16.26	-22.66	-22.56	29.20	0.88	18.85	0.1198	sp	merging
1141	260.55554	54.31577	260.55560	54.31813	16.24	17.06	-22.91	-21.42	16.59	0.66	19.43	0.1102	sp	merging
1142	260.64053	73.30917	260.64624	73.30388	16.01	17.04	-23.06	-21.63	40.05	0.61	19.23	0.1138	ph	non-merging
1143	260.74521	38.32410	260.74152	38.32709	16.72	16.84	-21.57	-21.75	29.36	0.14	19.67	0.1104	ph	non-merging
1144	260.85886	71.26280	260.83701	71.26434	14.11	14.18	-22.16	-22.60	17.99	1.32	17.51	0.0360	ph	merging
1145	261.31284	54.02799	261.32126	54.02582	16.45	16.46	-21.77	-21.71	36.18	0.68	19.07	0.1042	sp	merging
1146	261.45721	31.55057	261.45840	31.54456	14.92	16.35	-23.90	-22.29	38.45	0.86	18.12	0.0974	ph	non-merging
1147	261.90390	27.15114	261.90253	27.15467	15.74	16.94	-23.04	-21.77	25.62	0.58	19.63	0.1072	ph	merging
1148	262.58838	55.77737	262.59421	55.77687	16.53	16.93	-22.35	-21.84	23.83	0.49	20.59	0.1129	sp	non-merging
1149	262.64847	54.71286	262.64520	54.70845	15.01	16.76	-23.60	-21.61	30.91	0.47	19.29	0.0998	sp	merging
1150	263.05917	34.84614	263.06647	34.83995	15.20	15.68	-22.16	-21.73	38.68	0.37	19.59	0.0670	ph	non-merging
1151	263.12112	31.03676	263.11874	31.03912	15.06	16.16	-23.56	-22.47	22.08	1.47	18.47	0.1110	ph	merging
1152	263.31619	29.30383	263.31516	29.30686	15.59	16.52	-23.14	-22.34	23.65	1.59	18.75	0.1183	ph	merging
1153	264.89056	55.11989	264.90158	55.12386	16.12	16.84	-22.67	-21.39	47.88	0.39	20.66	0.0995	sp	non-merging
1154	265.19083	58.31756	265.18030	58.31945	16.75	16.94	-21.93	-21.57	44.06	0.29	20.93	0.1194	ph	non-merging
1155	266.78464	62.40006	266.78534	62.39667	15.10	16.94	-23.38	-21.53	22.52	0.52	19.10	0.1027	ph	non-merging
1156	267.90924	52.66175	267.91089	52.65571	15.15	16.74	-23.22	-21.94	38.46	0.92	18.77	0.0970	ph	merging
1157	268.08789	59.61363	268.09052	59.61320	16.17	16.72	-22.19	-21.87	9.25	0.27	20.38	0.1029	ph	non-merging
1158	268.25616	59.62018	268.24649	59.62656	16.33	16.36	-22.19	-21.91	49.28	0.79	20.17	0.0943	ph	non-merging
1159	268.29028	59.69229	268.29395	59.69153	15.73	16.52	-23.43	-21.79	12.06	0.23	18.04	0.0927	ph	non-merging
1160	268.62692	56.04895	268.61679	56.05005	16.45	17.25	-22.16	-21.36	42.39	1.48	20.65	0.1160	ph	non-merging
1161	269.31775	53.78119	269.32053	53.78739	16.32	16.84	-22.53	-21.88	46.93	0.02	20.72	0.1151	ph	non-merging
1162	315.30634	-6.43170	315.31039	-6.43292	15.59	16.33	-22.61	-21.92	26.22	0.43	18.41	0.0961	sp	non-merging
1163	316.42685	-5.61565	316.42664	-5.62292	15.85	15.98	-21.81	-21.90	39.40	0.08	18.74	0.0822	sp	non-merging
1164	317.66827	-6.57671	317.67401	-6.57772	16.24	16.56	-21.97	-21.59	33.73	0.58	21.01	0.0890	sp	non-merging
1165	321.57053	-7.17601	321.56696	-7.17955	14.85	16.68	-23.54	-22.16	30.18	0.07	18.94	0.0925	ph	non-merging
1166	323.41022	1.06867	323.40753	1.07095	15.86	15.99	-22.50	-22.23	19.90	1.10	18.01	0.0860	sp	merging
1167	325.61206	-6.58677	325.61096	-6.58024	14.85	16.44	-23.08	-21.67	38.30	0.20	18.86	0.0883	sp	non-merging
1168	328.26959	-1.01617	328.26788	-1.01583	16.46	17.19	-22.36	-21.66	13.12	0.25	20.71	0.1190	sp	non-merging
1169	328.39685	-8.69421	328.39621	-8.69803	16.57	17.04	-22.25	-21.84	28.78	0.45	20.53	0.1173	sp	non-merging
1170	328.52530	-8.64287	328.52725	-8.65017	14.23	14.74	-23.51	-23.11	35.28	0.61	17.15	0.0698	sp	merging

TABLE 1 – continued

No. (1)	RA_1 (2)	Dec_1 (3)	RA_2 (4)	Dec_2 (5)	r_1 (6)	r_2 (7)	M_{r_1} (8)	M_{r_2} (9)	D(kpc) (10)	a (11)	$r_{res,r}$ (12)	z (13)	z-flag (14)	Comments (15)
1171	329.37497	-0.16078	329.36981	-0.16055	16.23	16.58	-22.18	-22.04	35.63	0.77	19.17	0.1078	sp	non-merging
1172	331.22598	-8.45500	331.23080	-8.45319	16.12	17.21	-23.20	-21.62	37.95	0.02	19.92	0.1176	sp	non-merging
1173	331.90152	-9.50781	331.91049	-9.50806	15.78	16.36	-22.05	-21.40	48.10	1.00	19.54	0.0825	sp	non-merging
1174	333.09039	-7.34175	333.08774	-7.34197	16.42	16.80	-22.24	-22.22	19.50	0.25	19.08	0.1167	sp	non-merging
1175	334.45642	12.76494	334.46115	12.76862	16.44	17.07	-22.27	-22.09	44.51	0.14	20.05	0.1194	sp	non-merging
1176	334.91550	12.46653	334.92102	12.46660	16.79	16.92	-21.69	-21.71	38.21	0.07	20.76	0.1111	ph	non-merging
1177	335.70438	-9.03949	335.70334	-9.03734	15.59	15.72	-22.65	-22.00	13.13	0.53	19.39	0.0837	sp	non-merging
1178	335.83887	-8.94162	335.83966	-8.93983	15.49	15.53	-22.61	-22.46	10.79	0.24	18.91	0.0840	sp	non-merging
1179	336.34229	-8.70791	336.34689	-8.70099	16.04	16.19	-22.04	-21.71	45.92	0.15	20.26	0.0844	sp	non-merging
1180	336.54730	-8.74586	336.54205	-8.74304	15.84	15.90	-22.03	-22.08	32.44	0.71	19.34	0.0834	sp	merging
1181	336.83777	-0.67809	336.83572	-0.67916	14.85	15.53	-22.11	-21.74	8.90	0.35	18.47	0.0566	sp	non-merging
1182	337.10632	-9.62287	337.10687	-9.62511	15.26	15.46	-22.85	-22.37	12.65	0.82	18.03	0.0833	sp	merging
1183	337.66824	13.98012	337.67096	13.98432	16.06	16.85	-22.84	-21.84	36.97	0.55	19.12	0.1178	sp	merging
1184	337.67639	-9.82998	337.66925	-9.82938	15.89	16.25	-22.21	-21.58	40.64	0.22	19.60	0.0879	sp	non-merging
1185	338.39902	0.69693	338.40540	0.69722	15.94	16.71	-22.58	-21.58	43.61	0.15	19.58	0.1065	sp	non-merging
1186	338.81274	14.06910	338.80869	14.07062	16.06	16.08	-21.95	-22.00	22.99	0.16	19.38	0.0829	sp	non-merging
1187	339.20493	14.69852	339.20340	14.69897	15.01	15.98	-23.07	-22.20	9.15	0.42	19.36	0.0907	ph	non-merging
1188	342.85339	-9.76415	342.85425	-9.75661	15.11	15.69	-22.84	-21.92	40.35	0.09	18.35	0.0806	ph	non-merging
1189	343.64468	-0.57106	343.64426	-0.58025	15.19	15.73	-22.26	-21.72	41.88	0.16	18.21	0.0679	sp	non-merging
1190	343.75888	-0.37842	343.76273	-0.38516	15.65	15.98	-21.88	-21.56	36.09	0.13	18.78	0.0695	sp	non-merging
1191	344.11511	-0.54482	344.11786	-0.54829	16.55	15.96	-21.86	-22.73	31.10	1.39	19.42	0.1098	sp	non-merging
1192	344.48264	14.14971	344.48215	14.14779	14.97	15.97	-23.94	-21.81	11.62	0.34	18.80	0.0901	sp	non-merging
1193	344.52451	1.18620	344.52905	1.18817	16.18	16.33	-22.22	-22.39	32.75	0.24	19.31	0.1029	sp	non-merging
1194	345.83447	-10.56392	345.83191	-10.55735	15.98	16.89	-22.67	-21.56	49.63	0.16	20.75	0.1106	sp	non-merging
1195	347.59546	14.56765	347.59955	14.56388	16.07	16.91	-22.56	-21.66	38.53	0.36	20.89	0.1104	sp	non-merging
1196	349.39111	-9.09316	349.38425	-9.09122	15.82	15.86	-22.79	-22.65	40.09	0.08	19.89	0.0868	ph	non-merging
1197	349.48822	-10.14417	349.49463	-10.14698	14.69	15.81	-22.80	-22.72	32.64	0.25	18.95	0.0707	sp	non-merging
1198	349.97699	0.26378	349.97263	0.25924	16.96	16.99	-21.91	-21.78	47.16	0.45	20.50	0.1184	sp	non-merging
1199	350.60654	1.06559	350.60645	1.06919	16.09	16.16	-22.73	-22.56	26.99	0.27	20.58	0.1188	sp	non-merging
1200	350.78281	15.04363	350.78741	15.04422	16.41	16.43	-22.13	-22.18	31.92	0.39	19.48	0.1118	sp	non-merging
1201	352.25513	-8.94550	352.25491	-8.94727	16.47	16.54	-21.75	-21.75	11.03	0.11	20.54	0.0954	sp	non-merging
1202	353.60040	-0.89022	353.60406	-0.88378	16.26	16.71	-22.24	-21.66	49.60	0.14	20.17	0.1042	ph	non-merging
1203	355.10361	15.72200	355.10495	15.72715	16.72	16.95	-21.96	-21.64	38.40	0.41	22.69	0.1137	sp	non-merging
1204	357.58926	-8.88493	357.58652	-8.88589	15.62	16.53	-22.47	-21.50	16.02	0.80	18.95	0.0848	sp	merging
1205	358.52655	-10.42430	358.52933	-10.42133	15.57	15.96	-21.85	-21.74	19.00	0.23	19.52	0.0705	sp	non-merging
1206	358.66647	16.08228	358.66223	16.08075	15.02	15.96	-22.76	-21.60	21.92	0.28	18.26	0.0758	ph	non-merging
1207	358.94681	15.85121	358.94888	15.84999	15.85	16.20	-22.98	-21.99	13.62	1.03	19.58	0.0890	ph	merging
1208	359.94400	14.41535	359.94467	14.41688	16.33	16.41	-22.29	-21.76	9.86	0.36	19.99	0.0910	sp	non-merging
1209	359.99503	0.70175	359.99289	0.70241	14.98	15.48	-22.81	-22.21	11.27	0.17	18.90	0.0759	ph	non-merging

NOTE. — Col.(1): Number of pair; Col.(2): R.A.(J2000) of the first galaxy; Col.(3): Decl.(J2000) of the first galaxy; Col.(4): R.A.(J2000) of the second galaxy; Col.(5): Decl.(J2000) of the second galaxy; Col.(6): *r*-band magnitude of the first galaxy from SDSS pipeline; Col.(7): *r*-band magnitude of the second galaxy from SDSS pipeline; Col.(8): Our fitted *r*-band absolute magnitude of the first galaxy; Col.(9): Our fitted *r*-band absolute magnitude of the second galaxy; Col.(10): Separation of pair, in kpc; Col.(11): Asymmetry factor of pair; Col.(12): Residual magnitude of pair in *r*-band; Col.(13): Redshift of pair; Col.(14): "sp" for pair with spectroscopic redshift; "ph" for pair with photometric redshift only; Col.(15): Merging or non-merging classification.